Chapter 7.
Natural Resources and National Security, 1950–1953

Our natural resources programs are being modified in order to make the greatest immediate contribution to our national security.[1]

—Harry S. Truman

Beginning in July 1950, the United States slowly built up its forces in South Korea, as the major partner in the United Nations' effort to repel North Korea's invasion, while continuing to rearm at home and contain the Soviet Union abroad. The Truman administration proved woefully unprepared for a major war. The number of men and women in the Nation's armed forces, and their stores of equipment, had been reduced to dangerously low levels. At the end of 1948, 6 months after women were integrated into the military, the force totaled only 1.6 million and continued below authorized strength. Only the number of U.S. nuclear weapons rose significantly after World War II, to about 100, after Truman ordered increased production of bombs of the new design introduced in December 1948. The troops closest to Korea included 4 of the Army's 10 active, but understrength, divisions in Japan and 1 regimental combat team on Okinawa. The Navy kept the three *Midway*-class aircraft carriers in the Atlantic and the Mediterranean to counter any Soviet aggression but sent to the Pacific, as additions or replacements, other major warships as soon as they could be transferred from other areas or readied for sea. The Navy also ordered USS *Missouri* to Korean waters and began reactivating the three other *Iowa*-class battleships, a fleet carrier, and other reserve vessels. On July 3–4, 1950, aircraft from USS *Valley Forge* and HMS *Triumph* struck North Korean airfields at Pyongyang and Haeju. These and subsequent sorties, and those by the U.S. Far East Air Forces, destroyed most of North Korea's air force, but they did not interdict the North Korean People's Army (NKPA) columns moving south of the Han River.

Early on July 5, U.S. troops began combat operations against the North Korean ground forces.[2] The American infantry battalion, reinforced by additional crew-served weapons and a 105-millimeter (mm) howitzer battery, established a blocking position just north of Osan on the highway that connected Seoul and Suwon with Pusan. Although Task Force Smith lacked tanks, anti-tank mines, and air support, many of its members and military personnel elsewhere in South Korea and Japan expected an easy victory. The Americans valiantly tried but failed to stop two attacks by the main NKPA column, both led by Soviet-built T–34 tanks, as the U.S. 2.36-inch rocket launchers fared no better against the T–34s than they had against German Tiger tanks. The U.S. task force's remnants retreated beyond Osan, having delayed the NKPA column by just 7 hours at the cost of more than 150 men dead, wounded, or missing. U.S. overconfidence disappeared as well.

On July 7, as Lt. General Walton Walker arrived in Korea and President Truman asked the Selective Service System to resume the draft, the United Nations requested and approved General of the Army Douglas MacArthur, now the senior American officer on active duty, as overall commander of its forces in Korea. As additional Army battalions arrived piecemeal from Japan, they imposed additional

delays before withdrawing to a position in front of Taejon (now Daejeon). NKPA units captured Taejon on July 20, as Truman asked Congress for $20 billion to rearm the United States and a mechanism to mobilize America's resources to support the United Nations (U.N.) effort in Korea. On the same day, the Senate committee's report called false the repeated charges by Senator Joseph McCarthy that the Federal Government was rife with Communists.

The 8th Army slowed but did not halt the North Koreans' thrust south to conquer the remainder of the peninsula and retreated toward Taegu (Daegu), where General Walker established his headquarters on July 13. Walker withdrew his units toward the Naktong (Nakdong) River, where, on July 29, he issued a stand-or-die order. Although up-gunned versions of U.S. medium tanks, 155-mm medium howitzers, and 3.5-inch rocket launchers arrived to bolster the defense, 10 North Korean divisions closed on the line held by 4 U.S. divisions and 5 divisions from South Korea (Republic of Korea, ROK). The Pusan Perimeter, completed by August 4, enclosed an area of some 250 square miles.

The siege of the Pusan Perimeter began on August 8. The NKPA's assaults were aided indirectly by Soviet efforts in the United Nations, where Yakov Malik returned to the Security Council on August 1 (New York time) and assumed the Council's presidency. Thereafter, Malik vetoed every resolution about the conflict in Korea that the Soviet Union did not approve. To bypass Soviet opposition, the General Assembly, with Indonesia as its newest and 60th member as of September 28, adopted on November 3 the U.S. uniting-for-peace resolution that enabled it to take any emergency action required but vetoed in the Security Council. The United States continued to commit more of its active forces to Korea, and Truman ordered the activation of additional Army and Marine units and individuals in the National Guard and the Reserves.

The President then dealt with two pressing domestic issues. On August 25, 1950, Truman used a war-emergency law enacted in 1916 as the basis for ordering the Army to seize America's railroads to prevent the general strike the workers intended to call on August 28. The railroad workers decided not to walk out, but Truman did not return the railroads to the owners until May 1952. On August 28, 1950, he signed the Social Security Act Amendments, intended to "extend and improve the Federal Old-Age and Survivors System" and to modify the law's "public assistance and child welfare provisions."[3] The statute increased the post-1950 wage base for taxes to $3,600 per year, with a new schedule for payroll taxes; extended the system to more than 9 million people, including more of the elderly and those self-employed and those in the agricultural and home industries and in State and local governments; and hiked benefits by 70 percent.

As the 8th Army and ROK forces struggled to defend the Pusan Perimeter, and Syngman Rhee's government now in Pusan, more U.S. support personnel went into combat formations, South Koreans filled out American units, and reinforcements from other U.N. countries began to arrive in Korea. On September 1, 1950, Truman described the situation in Korea in a radio and television address to the Nation. The President reported that 30 U.N. members promised specific aid in Korea. Air and naval units from Australia, Britain, Canada, France, The Netherlands, and New Zealand were already participating in the conflict. Australia, Canada, France, Greece, the Philippines, Thailand, and Turkey, Truman added, also pledged additional ground-combat forces, while other nations promised medical, transport, or other combat-support units. The President reaffirmed U.S. policy in Korea by saying that the Nation would uphold the U.N. charter and South Korea's right to be free. "We do not want the fighting in Korea," Truman declared, "to expand into a general war," and it would not if the Communist Chinese stayed out, as he hoped they would. The United States had no territorial ambitions in the Far East, the President added, and, although "[w]e do not believe in aggressive or

preventive war," America would defend countries against external attacks. In Korea, Truman concluded, "[w]e want peace and we shall achieve it."[4]

As the U.N. Command's forces grew in Korea in 1950, the United States extended its efforts to contain Communism and defend the Pacific. The Governments of Australia, New Zealand, and the United States (ANZUS) began considering a security treaty for mutual defense and the peaceful settlement of any disputes between them. On September 1, 1950, the North Koreans launched another series of offensives around the Pusan Perimeter. The number of U.N. combat troops and supporting personnel within the perimeter rose by September 8 to numbers twice those of the overextended North Koreans. U.N. forces, now with a fivefold advantage in tanks, continued to control the air over and the sea around Korea.

As U.N. forces defended the Pusan Perimeter, the emergency in Korea and requirements for continued containment of the Soviet Union elsewhere began to affect profoundly the work of the civilian as well as the military components of the Truman administration. As Truman's actions in dealing with the Korean crisis won immediate support in the 81st Congress, national defense assumed priority over domestic issues. This change interrupted or delayed some activities by the Interior Department and other Departments and their bureaus but accelerated others. The renewed emphasis on and funding for national security forced a change in the orientation of programs by Interior and its agencies, as it did with the coming of American participation in World Wars I and II. The USGS, after a nearly 5-year effort to renew its research capital, again began shifting its regular mix of applied and basic studies to directing most of its operations to support the war in Korea, containment elsewhere, and military and civil-defense programs at home. The Geologic Division expanded and accelerated its investigations of strategic minerals, including those containing fissionable material; operations in military geology; activities in geology abroad; and studies of urban geology. The Topographic Division, at the request of the Army Engineers, reoriented and enlarged its program of topographic and related mapping. The Water Resources Division also changed many of its activities to meet defense needs. The Conservation Division's increased workload reflected the rising interest in the public lands and the heightened industrial tempo. Director Wrather and members of his staff remembered the lessons the agency learned during the two global conflicts earlier in the century. The USGS, Wrather promised, would devote its

> **best efforts to meeting the very real needs of national defense, yet the Survey, from its earliest days has been concerned with the wise utilization of our natural resources; instinctively, it will bear in mind the Nation's long-term needs during this present emergency as it has during other times of crisis.[5]**

As in World Wars I and II, the success of USGS contributions to ending the conflict in Korea would depend as much on the amount of funds that its planners and presenters could generate as it would on the operations by the agency's scientists, engineers, managers, and supporting personnel.

On September 5, a day before Truman signed the Interior Department's appropriations bill for fiscal year 1950–51, he advanced Federal records management by signing the Federal Records Act, which gave the Administrator "immediate custody and control of the National Archives Building and its contents" and "authority to design, construct, purchase, lease, maintain, operate, protect, and improve buildings" used to store "records of Federal agencies in the District of Columbia and elsewhere."[6] The new law established a National Historical Publications Commission, composed of the Archivist of the United States as chair, the Librarian of Congress, one member each of the House and Senate, one member

of the Federal judiciary, one representative each of the Departments of State and Defense, two members of the American Historical Association, and two members "outstanding in the fields of the social or the physical sciences" appointed for 4-year terms by the President. The statute authorized the Commission to "make plans, estimates, and recommendations for such historical works and collections of sources * * * appropriate for printing or otherwise recording at the public expense."[7] The act provided for a Federal Records Council, also composed of representatives of the legislative and judicial branches and of agencies in the executive branch. The Council would advise the Administrator in establishing "economical and efficient management of records in Federal agencies," formulate "standards for the selective retention of records of continuing value" and "assist Federal agencies in applying" them, inspect "the records of any Federal agency" to assure compliance, and "establish, maintain, and operate records centers for the storage, processing, and servicing of records for Federal agencies prior to their deposit with the National Archives [founded in 1934]." The law required the head of each Federal agency to "establish and maintain an active, continuing program for the economical and efficient [and safe] management of the records of the agency."[8] The act prohibited the National Archives from charging more than 10 percent beyond the cost of providing internal microfilming and other reproductions of records. On February 12, 1951, Oscar Chapman's Secretarial order established a Records Management Program for Interior.[9]

Before approving Interior's appropriations bill for fiscal year 1950–51, the 81st Congress and President Truman also inserted a new level of administration between the Interior Secretary and the USGS by following one of the Hoover Commission's recommendations. As of May 24, Reorganization Plan No. 3 of 1950 aimed to set the Department's resource activities on a more purposeful course. That enacted plan provided for one additional (programmatic) Assistant Secretary of the Interior, to "be appointed by the President, by and with the advice of the Senate, to perform duties prescribed by the Secretary of the Interior," and also authorized an Administrative Assistant Secretary to "be appointed, with the approval of the President, by the Secretary of the Interior."[10] On July 17, Secretary Chapman gave the now four Assistant Secretaries new programmatic titles—Administration, Mineral Resources, Public Land Management, and Water and Power Development—reflecting shifts in their supervisory responsibilities that Chapman backdated to June 9.[11] He also reassigned some of his agencies to reflect this new table of organization and established in the Office of the Secretary a Program Staff, to join therein the Solicitor's Office and the Information Division, and, on November 24, a Division of International Activities and a Director who reported to the Assistant to the Secretary. The new Division would (1) consider "the possible foreign impact" of Interior's domestic policies and programs; (2) supervise and improve "participation by Interior's representatives on committees dealing with foreign affairs"; (3) establish Interior's "viewpoint on international matters of concern to it"; (4) make good on Interior's commitments on foreign matters; (5) prescribe "procedures for the conduct of international activities; (6) foster "required cooperation and working relationships on foreign programs" by Interior's bureaus and offices; (7) review "legislative proposals involving the Department to determine their impact on foreign affairs"; and (8) maintain "continuing liaison"[12] with the State Department, other Federal agencies, the United Nations, and other international organizations.

When three persons then part of Chapman's managerial team and a returning colleague filled the four posts of Assistant Secretary, Chapman fixed their responsibilities on December 1.[13] Vernon Northrup, still the Director of the Division of Budget and Administration, received the new title of Administrative Assistant Secretary and the supervision of five Divisions—Administrative Services, Budget and Finance, Management Research, Personnel Management, and Property

Management. Chapman appointed Girard Davidson as the Assistant Secretary for Mineral Resources and made him responsible for developing and managing Interior's mineral programs, including those of the USGS, the U.S. Bureau of Mines (USBM), the Minerals and Fuels Division, the Division of Oil and Gas,[14] and the Division of Geography. Dale E. Doty, a Special Assistant to Chapman while the latter served as Under Secretary, became Assistant Secretary for Public Land Management and supervised the Bureau of Land Management (BLM), the Bureau of Indian Affairs (BIA), the Fish and Wildlife Service (FWS), the National Park Service (NPS), the Office of Land Utilization, and the Office of Territories, formerly the Office of Territories and Island Possessions. A Director still led the Office of Territories, as Chapman had renamed and reorganized it on July 28.[15] The office included, in addition to its Territorial Officers (principally the Governors and their staffs), the Chairmen of four new Branches—three geographical (Alaska, Caribbean, and Pacific) and one administrative. William E. Warne, the Assistant Secretary for Water and Power Development, managed the U.S. Bureau of Reclamation (USBR), but to it Chapman added the Division of Power and the Bonneville, Southeastern (established on March 21) and Southwestern (reorganized on October 23) Power Administrations. Chapman placed the appointments of the programmatic Assistant Secretaries on a rotational basis. Robert R. Rose, Jr., completed his single 2-year term in Wyoming's House of Representatives in 1951 and replaced Davidson as Assistant Secretary for Mineral Resources. Wrather came to view Rose as a real gain for the USGS, especially after Davidson responded to the Agriculture Department's objection to conclusions in a USGS Bulletin by asking the USGS to add to all its future publications a disclaimer that the agency's views did not necessarily reflect Interior's policy. Wrather, who viewed Davidson's request as "absolute poison"[16] for public confidence in the USGS, likewise convinced Chapman.

Early in 1950, Secretary Chapman also revived the issue of greater decentralization of Interior and its bureaus. He arranged to establish an outside group to assess Interior's field services, an Appraisal and Evaluation Committee composed of four academicians—Thomas C. Donnelly, James W. Fesler, Charles McKinley, and C. Herman Pritchett. Under a research contract with Interior, Executive Director Joseph E. McLean and his staff at Princeton University guided the Committee's 5-month review. L. Wade Lathram, Director of the Division of Management Research in Administrative Assistant Secretary Northrup's office, served as Interior's liaison to the Committee. Its report, dated September 15, 1950, asked Interior to give "careful consideration" to its existing organization to achieve "individual bureau efficiency and over-all departmental effectiveness"[17] by accelerating past and in-progress changes. The Interior Committee and the Princeton staff offered nine principal recommendations to Chapman: (1) make continued efforts throughout Interior to regard and manage land, water, and mineral resources "as a unity";[18] (2) increase the Secretary's staff to facilitate "planning, programming and supervision of policy execution"; (3) designate "a Secretarial officer as full-time director of the Program Staff and as chairman of the Program Committee"; (4) obtain "similar degrees of decentralization within the bureaus" and "[r]oughly uniform (but fluid) regional boundaries and to the greatest extent possible common field headquarters";[19] (5) fully recognize and adequately finance the key position in each field committee to "promote long-range needs" and facilitate the intradepartmental and interdepartmental coordination of bureaus and similar coordination with their State, municipal, and private cooperators; (6) make every effort "to incorporate areal as well as functional considerations in the budget process";[20] (7) keep unchanged, "for the time being," the "present [river-basin-based] regions of the field committees," except possibly for the Eastern Region; (8) reinforce, via Interior's "top management," "present efforts to develop a department-wide career service";[21] and (9) take "[i]mmediate steps * * * to decentralize personnel authority over professional legal personnel."[22]

The Interior Committee-Princeton report then made specific recommendations for improving the internal organization and external relationships of the USGS and seven other Interior agencies. The report did not critique the quality of USGS work. Instead, it recognized the indispensability of the USGS "to the intelligent utilization of resources and the maintenance of America's technology"[23] and its rightful recognition "as an outstanding scientific group, with some of the world's most brilliant scientists among its personnel." The report did emphasize that

> **the organizational pattern through which the Survey operates deserves considerable criticism.[24]**

The Interior Committee-Princeton report constructively hammered the USGS, both internally and externally. Asserting that the USGS since its founding had "remained virtually indifferent to questions of organization"[25] and did not respond effectively to changes during and after World War II, the report claimed the agency's "professional scientists, losing themselves in the technical aspects of their protracted projects, ignore the advantages efficient administration can give to them." On June 30, 1950, the USGS employed 1,300 persons at its headquarters and another 7,257 at field locations. The headquarters staff represented 15 percent of the agency's total employees, the largest ratio of Interior's agencies. With the USGS organized into programmatic rather than geographic Divisions, the "integration of Geological Survey work in specific regions is thus not the responsibility of any official short of the Director's Office." "Indeed," the report continued, "the integration of its findings is not an important objective of the Survey," which left that task "to those who utilize Survey data."[26] The report reviewed perceived problems in integrating and controlling planning and programming, personnel, property management and accounting, and procurement and made six principal recommendations for improvements. After evaluating the arguments for and against regionalization, the report favored the USGS establishing "a common regional pattern"[27] in which field organization followed the boundaries of the field-committee regions, decentralizing agency operations, and delegating "authority for program formulation and execution"[28] to regional directors. To assist regionalization, the report recommended "that review of maps and publications in the regions be handled by these specialists," "committees of regional division heads be appointed in each region to assist * * * in coordinating programs," and "small technical libraries be set up in each region." More specifically, the report recommended that "the staff of specialized geologists attached to the Director's Office should be advisors only"[29] and that the Water Resources Division should "maintain a single district office in each state to provide contact with state cooperators."[30]

To improve USGS relations within and without Interior, the Interior Committee-Princeton report recommended three prime changes. The USGS must "continue to expand its formal and informal relationships with related agencies"[31] and aid an "intensive study * * * directed toward the clarification of a national minerals policy" to end the confusion created by the area of "uncertain responsibilities between"[32] the USBM and the USGS. Although the scientific classification of the public lands was one of the two founding missions of the USGS, the Interior Committee-Princeton report, recognizing that the Conservation Division's regulatory activities had "no place in a basic research and service agency,"[33] recommended abolishing the Division and transferring its functions, funds, and staff. The report suggested sending the Mining Branch and the Oil and Gas Leasing Branch to the BLM; the Mineral Classification Branch to the USGS Geologic Division; and the Water and Power Branch to the USGS Water Resources Division or to the USBR or to the Federal Power Commission.

Wrather had dissuaded Secretary Krug from requiring the USGS to increase its decentralization and appoint regional directors. Wrather gave Chapman his views

on why and how the USGS had already decentralized its field operations as much as he thought good management and operations allowed. The regional coordinating committees established with representatives from all Divisions would continue to function, but Wrather wanted to keep intact the direct lines of management between the Division Chiefs and the Assistant Director and Director. Wrather, in his memorandum of December 21, 1950, written in response to the Interior Committee-Princeton report[34] and after his meeting with Chapman, asked his Division Chiefs to restudy consolidation to locate field headquarters at field centers to facilitate operations and avoid any inefficient and uneconomical dispersion wherever possible. The surplus ammunition plant west of Denver facilitated the choice of a site for the Rocky Mountain field center, but no equivalent location seemed available on the West Coast reasonably near existing USGS offices in California, principally those in Sacramento and San Francisco. To secure a western site, USGS managers began extended but ultimately unsuccessful discussions with Stanford administrators about constructing a USGS center on campus and sharing it with the Department (now School) of Earth Sciences. Adequate space at Berkeley also proved impossible to obtain. When Thomas Osborne, of the General Services Administration's (GSAd's) San Francisco office, found no suitable existing facilities for lease in the bay area, he requested bids to build and lease one in the Palo Alto area. The USGS, through Osborne, negotiated a $550,000 low-bid contract to construct 40,000 square feet of office space, with adjacent open land, at Menlo Park, near Palo Alto. The new facility was intended to house between 175 and 225 persons, including the USGS people at the Old Mint Building and other locations in San Francisco. Later, as additional buildings were constructed at the new site (overseen by David Gallagher from December 1952), plans called for some of the USGS staff in Sacramento to relocate to Menlo Park.

On September 6, 1950, when Truman signed the Interior Department's appropriations bill for fiscal year 1950–51, the President and Congress also agreed to send $62.5 million in Marshall Plan aid to Spain. The latter decision represented another step in the long process of restoring Spain to the West's good graces and adding her armed forces to those of the North Atlantic Treaty Organization (NATO). The appropriations act gave Interior about $623.3 million, some $46.2 million less than Chapman requested. The new law provided the USGS with $19,382,000, about $3.24 million more than the total of direct and deficiency appropriations the agency received for fiscal 1949–50. The statute also ended the line itemization of the USGS budget, a requirement in effect since 1888 and, since then, a constant reminder of one of the major results of Director Powell's failed policies and practices. The act replaced line itemization with the Interior-requested authorization for funds for

> **surveys, investigations, and research.[35]**

The new law returned the agency to its block-funded status of 1879–87 and allowed it to make decisions on how it would best use its own direct appropriations in the Nation's interest. The statute compressed the agency's brief into two parts. The first paragraph described the nature of USGS work:

> **For expenses necessary for the Geological Survey to perform surveys, investigations, and research covering topography, geology, and the mineral and water resources of the United States, its territories and possessions; classify lands as to mineral character and water and power resources; give engineering supervision to power permits and Federal Power Commission licenses; enforce departmental regulations applicable to oil, gas, and other mining leases, permits, licenses, and operating contracts; and publish and disseminate data relative to the foregoing activities.[36]**

This section also continued the limits on the use of USGS funds for surveys, investigations, and research (SIR) for cooperative work with nonfederal agencies. The agency's direct appropriation included $3.1 million "available only for cooperation with States or municipalities for water resources investigations," and the law also required that "the share of the Geological Survey in any topographic mapping or water resources investigations carried on in cooperation with any State or municipality shall not exceed 50 per centum of the cost thereof."[37]

The second paragraph covered USGS administrative provisions. This section made the entire "amount appropriated [as the agency requested] available for personal services in the District of Columbia"; allowed the purchase of no more than 129 "passenger motor vehicles," of which 85 could only be replacements; authorized "printing and binding"; required reimbursing the GSAd for security guard services, enabled "construction and maintenance of necessary buildings and appurtenant facilities," approved the "acquisition of lands for gaging stations," and authorized

> **contracting for the furnishing of topographic maps and for the making of geophysical or other specialized surveys when it is administratively determined that such procedures are in the public interest.[38]**

The funds received from other sources raised the total monies managed by the USGS in 1950–51 to about $36,373,000, an increase of nearly $5.8 million over the previous fiscal year. Of the new sum, 51 percent came from direct appropriations for SIR activities, later reported by the USGS as some $18,429,000. Other Federal agencies furnished more than $13,346,000, or 37 percent, and States, counties, and municipalities supplied nearly $4,519,000, or 12 percent. The USBR led the group of civilian agencies transferring more than $100,000 each by providing about $4,871,000. The U.S. Atomic Energy Commission (AEC) furnished nearly $3,189,000, Interior's new Defense Minerals Administration (DMA) gave almost $281,000, the Department of State (DoS) provided nearly $585,000, the Economic Cooperation Administration (ECA) supplied some $167,000, the BIA shifted about $118,000, and other Federal sources combined to produce another $642,000. The Army and its Engineers transferred more than $2,207,000, the U.S. Air Force (USAF) furnished about $659,000, and the U.S. Navy (USN) supplied $451,000. The USGS received nearly $746,000 for general administration, a raise of about $346,000 over the previous year's total. That new sum for general administration represented an increased direct appropriation of nearly $77,000 and the total of $269,000 transferred by the AEC, the USAF, the Army, the BIA, the USBR, the DMA, the ECA, the USN, and the DoS.

On September 8, 1950, 2 days after approving Interior's direct appropriations for fiscal year 1950–51, the 81st Congress and President Truman responded to the demands of wars hot and cold by approving a defense-production bill, introduced in the House on July 19, aimed in part at assuring an adequate and continuing supply of mineral raw materials. Truman also issued an Executive order delegating to the Secretary of State[39] the responsibility for carrying out the Point Four Program approved by Congress. The Defense Production Act provided for establishing "a system of priorities and allocations for materials and facilities" and authorized "the requisitioning thereof"; provided "financial assistance for expansion of productive capacity and supply," "price and wage stabilization," and "the settlement of labor disputes"; strengthened "controls over credit"; and "by these measures" facilitated "the production of goods and services necessary for the national security."[40] The new statute authorized purchases from or loans and grants-in-aid to private business enterprises to expand their productive capacities, develop technological processes, and produce essential materials, "including the

exploration, development, and mining of strategic and critical minerals"[41] under Federal approval and supervision.

On September 9, Truman, in another radio and television address to the Nation, promised that the Defense Production Act would ensure the production of the materials and equipment required for national defense, raise workers' salaries, and prevent inflation. The President's Executive order issued earlier that day established an Economic Stabilization Agency and also authorized and directed the Secretary of the Interior "to encourage exploration, development, and mining of critical and strategic minerals and metals."[42] Truman took additional steps to secure and maintain the resources required for national defense. On September 11, the President and the Secretary of Commerce founded the National Production Authority (NPA) and appointed Manly Fleischmann of New York as its Administrator. Truman signed additional legislation on September 27 that gave the GSAd slightly more than $598,637,000 during fiscal year 1950–51 to fulfill the provisions of the Strategic and Critical Minerals Stock Piling Act of 1946. Not more than $14 million of that sum would "be available for transfer to the appropriation 'Operating Expenses,' for the reactivation of industrial plants [mothballed] under the provisions of the National Industrial Reserve Act of 1948."[43] On October 13, Wrather's Survey order designated Harold Bannerman as the Director's deputy "to maintain liaison with" Interior, the USBM, "and other agencies concerned with such functions"[44] as Secretary Chapman might redelegate to the USGS and to draft policies for and to administer USGS operations by its Geologic Division and its other Divisions as might be required under the Defense Production Act.

The security of a long-term supply of oil for the United States remained one of the most important issues involving these strategic and critical materials, as the Nation continued increasing its net imports and consumption of petroleum. The Senate, in the midst of its debate on the defense production bill on August 15, authorized its Committee on Interior and Insular Affairs to study available fuel reserves, except atomic energy, as well as present and probable future rates of consumption. The Senate intended this assessment to aid in formulating a national fuels policy to meet the needs of the United States in peace and war, including recommendations for methods to encourage development to assure the availability of fuels adequate to serve an expanding economy and security requirements. As in earlier postwar years, some persons argued for importing more oil in peacetime to preserve domestic resources for use in war and others urged the development of a synthetic-fuels industry.

The development of technology for drilling offshore now offered a third possibility, the resources of the Continental Shelves, but one that became a partisan issue. Wrather, in testifying before a Senate committee investigating during June 1945 possible new sources of petroleum, suggested as promising targets the world's Continental Shelves. The results of the hearings contributed to Truman's proclamation, on September 28, 1945, that asserted U.S. jurisdiction over the natural resources of the subsoil and seabed on the Nation's contiguous Continental Shelves. A year later, Everette DeGolyer reported that geophysical surveys had discovered in the shallow waters in the northern Gulf of Mexico, between the mouths of the Mississippi and Sabine Rivers, no fewer than 30 salt-dome structures similar to those already producing petroleum in adjacent onshore areas. By then, Louisiana, which claimed jurisdiction out to 27 miles from her coast, had leased some 375,000 acres to exploration companies that had drilled five wells from fixed platforms. Four other wells had been similarly drilled off Texas. When Kerr-McGee discovered oil on October 4, 1947, by drilling from a floating platform of three linked Navy surplus vessels anchored 12 miles off Louisiana's coast, both the Federal Government and the States promptly claimed ownership of the Continental Shelf. After the U.S. Supreme Court dismissed California's claim by ruling in June 1947 that the Federal Government had full dominion over the underwater resources,[45]

Federal suits followed against Louisiana and Texas in 1948. On June 5, 1950, the Justices approved the Federal case in ruling against those two States. Chapman's subsequent Secretarial order of September 18 delegated to the USGS Federal Oil and Gas Supervisor in Los Angeles Interior's authority in the 1947 agreement between the Attorney Generals of the United States and California "respecting mineral operations in the submerged lands and tidelands lying along the California coast"[46] but reserving to the State 30 days' rights of appeal to the USGS Director and the Interior Secretary.

Chapman further addressed the issue of sufficient oil supplies by also establishing on October 3, 1950, the Petroleum Administration for Defense[47] (PAD) and gave himself, like Harold Ickes, another hat as its Administrator. Secretary of Defense Johnson had approved the transfer of the Army-Navy Petroleum Board from the Joint Chiefs of Staff to the Munitions Board, effective May 1, 1949. Chapman selected Bruce K. Brown to be the PAD's Deputy Administrator; Brown, formerly Harold Ickes' Assistant Deputy Administrator of the Petroleum Administration for War (PAW), was now Chairman of the Military Petroleum Advisory Board and a member of the National Petroleum Council. The PAD's Assistant Deputy Directors included Alfred P. Frame, later Associate Deputy Administrator; C.E. Davis, for domestic operations; Stribling Snodgrass, another veteran of the PAW and DeGolyer's Middle East Oil Mission in 1943–44, who now took over foreign operations; and Hugh A. Stewart, who also served as Director of Interior's Oil and Gas Division. James Brazil, the geologist and Navy officer who worked in Naval Petroleum Reserve No. 4 (NPR–4) in 1944, served 2 years as Administrator and Executive Officer in Commodore Greenman's Office of Naval Petroleum and Oil Shale Reserves (ONPR), and then returned to the petroleum industry, came back as Chief of the PAD's Exploration and Reserves Branch.

The PAD immediately asked the USGS to investigate the nature and occurrence of the Scurry Reef oil fields, stratigraphic reservoirs discovered jointly by Humble and Sun in July 1948 in Scurry County, northwest of Abilene, in the Midland Basin of western Texas. By the end of 1949, the 315 wells in the Scurry fields had produced nearly 4.3 million barrels of oil. Exploration and production, from January 1948 by Seaboard and other companies, in adjacent Borden and Howard Counties to the west began to define these limestone-reef complexes as part of a much larger structure, the 90-mile-wide Horseshoe Atoll of Pennsylvanian and Early Permian age. The results of the USGS studies, the PAD hoped, would advance more reasoned development in these fields that might yield at least 2.5 billion barrels overall. In December 1950, the USGS sent petroleum geologist Howard E. Rothrock to Midland to lead the agency's regional study of the Horseshoe Atoll and its reservoir problems, in cooperation of the Bureau of Economic Geology at the University of Texas.

Under 1950's Defense Production Act, as amended and extended[48] on July 31, 1951, the Interior Department received responsibilities for metals and minerals, solid fuels, electricity, and fishery commodities to add to its work in petroleum and natural gas. To carry out these new duties, Secretary Chapman established, on December 4, 1950, four new Defense Administrations.[49] The new organizations were Fisheries; Minerals, or Minerals Exploration, as of November 20, 1951; Power, or Electric Power, as of February 5, 1951; and Solid Fuels, similar to the one that operated during World War II. On December 5, 1950, Chapman appointed Albert M. Day as head of Fisheries, USBM Director and former Army Engineer Colonel James Boyd as head of Minerals, D. Loring Marlett as head of Power, and Dan H. Wheeler as head of Solid Fuels. USGS members helped Interior and Boyd to plan and organize the Defense Minerals Administration to increase the production and quantity of strategic and critical minerals. The DMA quickly assigned new duties for minerals to the USGS. Interior also involved the USGS with the Defense Solid Fuels Administration as well as the Petroleum Administration for Defense.

Congress, responding to the recent prolonged coal strike, generated a variety of resolutions and bills but passed none of them. The Korean crisis made the matter more urgent. At a Senate committee's request, Chapman set up a staff group to work with the committee's staff to develop background information to which the USGS contributed a comprehensive statement on fuel reserves.

On January 3, 1951, as the 82d Congress began its first session, Truman's Executive order drew on the authority he received under the Defense Production Act in founding the Defense Production Administration[50] (DPA), as part of the National Production Authority, and the President gave the new organization general charge of the NPA's defense program. Truman appointed Edwin T. Gibson, a director of General Foods Corporation who retired in 1951, as the DPA's Acting Administrator. On June 2, Congress and the President agreed to provide nearly $27,332,000 in additional funds as a supplement for defense-production expenses during fiscal year 1950–51, provided that the year's appropriations be made available for renting and (or) repairing buildings "in the District of Columbia and elsewhere," without regard for the restrictions of the law enacted in 1933 and provided that the funds were used to reimburse Presidential appropriations for defense allocated to agencies to carry out the provisions of the Defense Production Act. The supplemental-appropriations act extended the aggregate of outstanding funds borrowed by the Treasury Department from $800 million to $1.6 billion. This law also authorized transfers between agencies of defense appropriations or allocations for salaries and expenses but prohibited any such allocation if the agency could perform its defense activities "by its regular personnel by use of the foregoing authority to realign its regular programs."[51] To conserve building and related materials for use in mobilizing the country for defense, the NPA announced on January 15, a 30-day nationwide ban, effective February 15, on all construction by commercial firms.

As Congress and the President acted to improve national defense, Director Wrather made additional significant changes in USGS administration during fiscal year 1950–51 to try to manage more effectively operations by the agency's employees. On December 21, Wrather's memo to Secretary Chapman provided for field centers to accommodate the USGS' growing activities within the agency's established geographic regions. On the next day, Wrather reassigned the Office of the Chief Counsel to the Director's Office.[52] Less than a month later, Wrather established an Alaska Survey Committee, composed of representatives from each Division. The Director appointed William S. Twenhofel (William H.'s son) as interim Chairman, until the first annual leader was elected from among the members on January 1, 1952, to "act as the Survey representative in Alaska on matters affecting the Survey as a whole, or affecting more than one Division,"[53] as advised by the Committee. Wrather made the Management Services Officer the Committee's Executive Secretary and asked Twenhofel to convene the Committee once a month. In the Director's Office, James J. Ryan became Chief of the new Branch of Service and Supply. To make the results of USGS investigations more rapidly available to users in academia, government, and industry, Wrather and the Division Chiefs arranged to have more of them issued in preliminary form in the series of Circulars; revised versions of some of them later appeared again as Circulars or as Bulletins or Professional Papers.

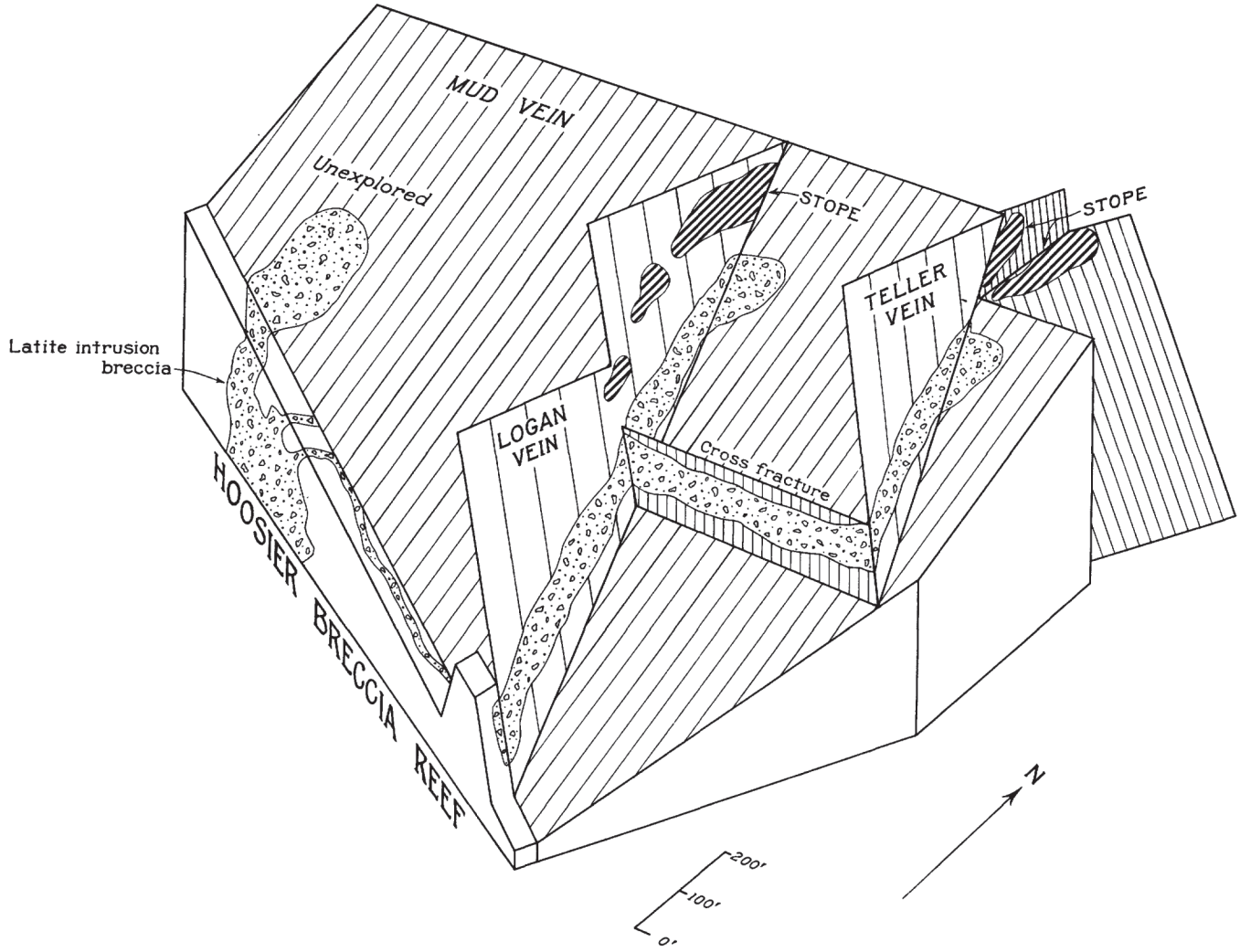
Wilmot ("Bill") Bradley's Geologic Division, like the Topographic Division, reoriented its programs during fiscal year 1950–51 to increase its support of national defense. During the year, the Geologic Division managed about $9,698,000, including nearly $4,074,000 in direct appropriations, or 42 percent, for geologic and mineral-resources surveys and mapping, an increase of almost $1.3 million from the previous year's total. Outside sources supplied another

$5,624,000, or about 58 percent of the Division's funds. Military transfers totaled nearly $994,000, mostly from the Army and the Navy. The AEC shifted to the Division more than $2,946,000, or almost $451,000 more than in fiscal 1949–50. Other civilian Federal agencies transferred a total of some $1,479,000, including nearly $477,000 from the State Department, about $455,000 from the USBR, $279,000 from the DMA, $161,000 from the ECA, and $54,500 from the PAD. For cooperative geologic work, seven States and several counties and municipalities gave about $205,000, a gain of $119,000 from the past year.

To improve the coordination of plans and operations by personnel in the Geologic Division's branches at Denver, Bradley assigned Raymond C. Becker as Staff Geologist at that city's Federal Center. Becker, as geologist in charge and chief administrator at Denver during 1951–62, also guided Building 25's conversion from its munitions-related internal layout to USGS offices and laboratories and coordinated USGS work for the Missouri River Basin interagency program.

Geologists in Olaf Rove's Mineral Deposits Branch during 1950–51 conducted 90 separate studies of more than 30 different mineral commodities in more than 30 States. About three-quarters of the Branch's programmatic work focused on strategic minerals; most of the other projects involved iron, phosphate, potash, and other commodities, which, although not classified as strategic, remained essential to the Nation's continued economic welfare. Vincent McKelvey, Richard P. Sheldon, Earle R. Cressman, Montis Klepper, Roger W. Swanson, and other Branch and AEC geologists explored, sampled, and made tonnage-grade studies, especially in the phosphate fields of Florida, Idaho, and Montana. They also published an analysis of the relation of pebble-phosphate deposits to the Pleistocene shorelines of Florida and Georgia and began investigating phosphate- and uranium-bearing sediments off Florida's west coast. Geologic mapping by Harold James, Carl E. Dutton, and their colleagues in the Iron River-Crystal Falls Range in Michigan's Upper Peninsula led to the discovery of important new iron-ore deposits and new ore-bearing areas. David Gallagher completed his tour as Chief of the Colorado Plateau Project in 1950 and then led a DMA field team in Joplin in Missouri. Richard Fischer and other members of the Colorado Plateau Project[54] and of projects on related work in the West, still funded by the AEC, expanded their reconnaissance surveys for and sampling of uranium and other radioactive materials in carnotite, coals and related carbonaceous rocks, oolites, phosphates, and other deposits in Arizona, Colorado, Idaho, Montana, New Mexico, South Dakota, and Wyoming, while continuing to advise the USBM about drilling operations. Lorin Stieff and Thomas W. Stern completed a report that described new techniques for preparing photographic emulsions used to determine the location and concentration of uranium and other radioactive elements in rock samples by recording their alpha-particle tracks.

Elsewhere in Rove's Branch, Thomas Lovering and Edwin Goddard continued studies of Colorado's Front Range begun in the 1870s by S. Franklin Emmons and carried on by a number of his coworkers and their successors in the USGS. Lovering and Goddard published a comprehensive report on the geology and ore deposits of the Front Range and its more than 30 mining districts. The USGS also issued an earlier study of the beryl- and mica-bearing pegmatites in Idaho and Montana by Walter C. Stoll. For the new DMA, Rove's commodity geologists recommended special programs designed to reduce deficiencies in the supply of 23 strategic and critical minerals. They also processed some 500 of the nearly 800 applications for Government assistance in locating and developing deposits of nearly 50 commodities and completed about 100 field examinations. For the National Security Resources Board, newly revitalized under Stuart Symington's leadership, Branch specialists finished confidential reports of the world's resources of 12 strategic metals and minerals and began similar studies of 34 other mineral commodities.



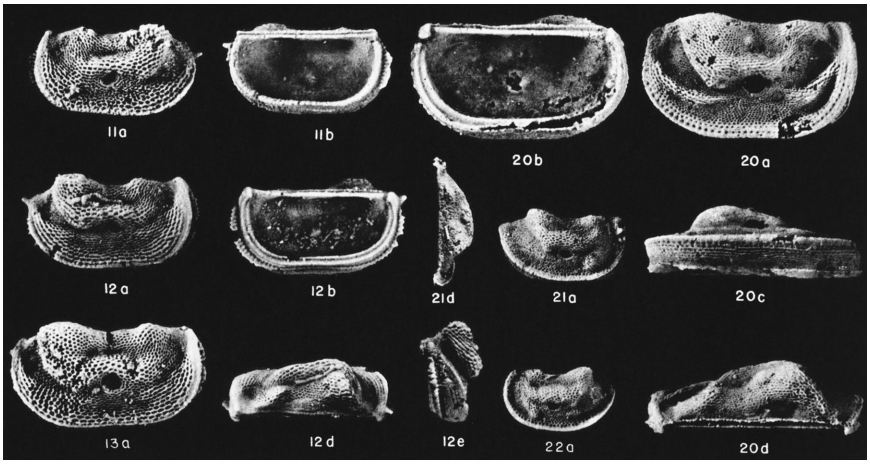
This block diagram shows the relation of potassium-rich and biotitic latite dikes and intrusion breccias to the gold-telluride ore shoots in Colorado's Logan Mine, 1 of 95 mines in the Gold Hill district west of Boulder. Thomas Lovering's and Edwin Goddard's study of the district formed part of their investigations from 1930 of the geology and mineral resources of the Front Range between the Colorado-Wyoming border and Cañon City. They and their USGS colleagues conducted their work "in cooperation with the Colorado Geological Survey Board and the Colorado Metal Mining Fund." The Logan Mine, like most other mines in the district, yielded medium- to high-grade ore taken mostly from gold-telluride fissure veins and lesser amounts of silver from silver-lead veins. The Logan Mine was "well known for its rich free-gold ore," but, unlike most of the district's other mines, the Logan also produced "[m]oderate amounts of tungsten ore" from a shoot north of its "Mud vein near [the] intersection with [its] Hoosier [breccia] reef." Lovering and Goddard assigned the mineralization in the Front Range, except in the Cripple Creek district, to the Laramide orogeny (Late Cretaceous-early Tertiary). (Quotations and diagram from Lovering and Goddard, 1950, p. 7, 238, and 254 and fig. 24; see also Lovering, 1941, and Morris, H.T., 1996.)

Wrather and Nolan personally reviewed the relations between the Geologic Division's Trace Elements Planning and Coordination Office (TEPCO) and the AEC's exploration group in the Western United States. Their studies included the area around Arizona's Monument Valley, a locale readily identified by the public through images from film director John Ford's westerns since his *Stagecoach* in 1939. Wrather and Nolan worked to resolve problems connected with duplication of assignments and to reach an agreement to divide the geology and exploration functions, return geology to the USGS, and leave development and production with the AEC. Other members of the Geologic Division began similar studies in California after Truman signed, on September 25, 1950, an act that authorized the USGS, the USBM, and the NPS to survey the "area within the revised boundaries of the Joshua Tree National Monument" and to determine and report to Congress by February 1, 1951, about whether the "area is more valuable for minerals than for the National Monument purposes for which it was created."[55]

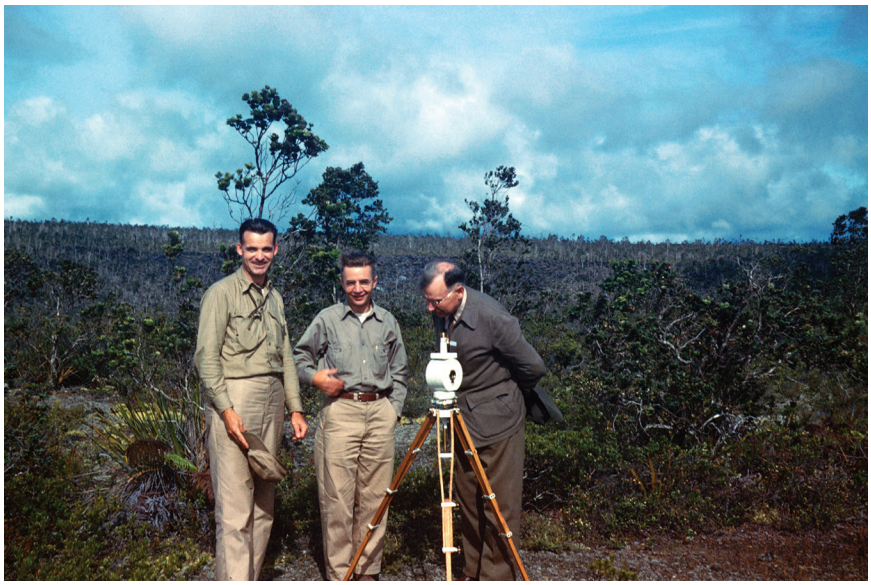
Carle Dane's Fuels Branch began or continued nearly 60 regional oil and gas investigations, ranging from detailed bed-by-bed mapping of outcrops to using well samples to correlate subsurface sequences, in more than 20 States in fiscal year 1950–51. Branch geologists better determined the extent, depth, and reserves of the richer oil-shale zones of the Green River Formation in northwestern Colorado and in northeastern Utah. Donald C. Duncan and Carl Belser published a map

of the distribution, thickness, depth, and estimated reserves of the oil shales in Colorado's eastern Piceance Creek Basin. To guide development of the Scurry and other reef-crest or reef-flank oil fields in the Midland Basin's Horseshoe Atoll, Howard Rothrock, Donald A. Myers, Robert T. Terriere, and other specialists worked, in cooperation with the PAD, the Texas Bureau of Economic Geology, and the USBM, to establish the regional correlation of the basin's Pennsylvanian and Permian rocks. Rothrock's team also began investigating the reefs' biotas, petrography, petrology, sedimentology, stratigraphy, and structure, as well as their petroleum occurrences. To support these efforts, Helen M. Duncan, Mackenzie Gordon, Jr., Donald Myers, Gregory Sohn, Keith A. Yenne, and Ellis L. Yochelson evaluated the reefs' brachiopods, bryozoans, corals, fusulinid foraminifers, gastropods, ostracodes, and other fossils. As part of the continuing and now more urgent task of reappraising the coal resources of the United States, Paul Averitt, Henry L. Berryhill, Jr., Andrew Brown, Donald M. Brown, George V. Cohee, Charles B. Read, Frank D. Spencer, James V.A. Trumbull, Gordon H. Wood, Jr., Alfred D. Zapp, and their colleagues published new detailed estimates of coals in Michigan, New Mexico, and Wyoming. They also continued general and detailed examinations of coal resources in Indiana, Kentucky, Montana, North Dakota, Oklahoma, South Dakota, and Virginia, including coking coals in Indiana, Kentucky, and Montana. Louise R. Berryhill (Henry's wife) and Paul Averitt prepared an overall view of the coking-coal deposits in the West. Core-drilling results and field studies by William J. Mapel, James Schopf, and James R. Gill in the area around Lake DeSmet, northwest of Buffalo in Johnson County, Wyoming, revealed a continuous bed of subbituminous coal about 100 feet thick, under less than 100 feet of overburden, and in an area of about 2.5 square miles.

Geologists in Edwin B. Eckel's Engineering Geology Branch conducted 25 field projects in 14 States during fiscal year 1950–51, paying special attention to the occurrence and causes of landslides. They continued their contributions to Interior's program for developing the Missouri River Basin, still the Branch's principal effort, and to mapping with construction agencies in Arizona, Colorado, Massachusetts, Rhode Island, Washington, and Puerto Rico to provide data on bedrock depth, sources of construction materials, foundation conditions, industrial-plant sites, irrigation suitability, landslide-area stability, and reservoir capacity. To advance national defense, they expanded the Branch's program of mapping larger U.S. cities by continuing work in Portland in Oregon and Knoxville in Tennessee and by investigating locales for underground shelters in San Francisco[56] and alternate sites for bridges across San Francisco Bay. Studies also included research to determine the effect of water-level fluctuation on landslides in the Upper Columbia River Valley, an assessment of sand and gravel resources of NPR–3 around Teapot Dome in Wyoming, and an evaluation of the Rocky Flats plant site near Denver.



These benthic marine ostracodes, representing three species of the new genus *Aurikirkbya*, were collected from an outcrop in the upper part of the Leonard Formation (Permian) in the Glass Mountains in Texas. USGS paleontologist Gregory Sohn's measurements of the frequency distribution of hinge length demonstrated growth series for both valves in 252 specimens of *A. wordensis* (Hamilton). Paleontologists studied these and other fossil ostracodes—tiny freshwater and marine crustaceans recovered from surface samples and well cores—to determine their relative geologic ages, to correlate their enclosing rocks or sediments, and to interpret the environments in which they lived. (From Sohn, 1950, pl. 7, figs. 11a,b; 12a,b,d,e; 13a; 20a,b,c,d; 21a,d; and 22a; all figures originally shown at about × 18.)



Ray Wilcox photographed (from left to right) geologist Gordon Andrew Macdonald (1911–78), geophysicist Henry Rochambeau Joesting (1903–65), and geologist Ruy Herbert Finch (1890–1957) in 1951, as they looked at a USGS magnetometer used in ground surveys of Kilauea Volcano in Hawaii Volcanoes National Park. Macdonald, who joined the USGS in 1939, served as Director of the USGS Hawaiian Volcano Observatory (HVO) in 1951–55, before moving to the Hawaii Institute of Geophysics (see Lockwood, 1980). Joesting worked on Jan Mayen Island northeast of Iceland, and in New Mexico, Venezuela, and Alaska until 1944, before supervising the U.S. Bureau of Mines' geophysical explorations for war minerals and then serving as Chief of the USGS Geophysics Branch (1946–53; see Henderson, R.G., 1965). Finch joined the HVO in 1919 and worked at Lassen Peak during 1926–35. He succeeded the HVO's founder Thomas A. Jaggar when Jaggar retired as Director in 1940. Finch led the HVO until 1951. The USGS magnetometer surveys formed part of a growing number of geophysical, geological, and related scientific investigations aimed at increasing knowledge of the nature and behavior of Kilauea and other Hawaiian volcanoes to enable more accurate predictions of eruptions. (Photograph from the USGS Denver Library Photographic Collection as Wilcox, R.E., wire0529, https://www.sciencebase.gov/catalog/item/51ddd113e4b0f72b44721c71; see also Macdonald, 1958.)

In Charles Hunt's General Geology Branch, 1950–51 brought a major change in the Hawaiian Volcano Observatory's management. As approved by Wrather, Bradley, and Hunt, Gordon Macdonald succeeded retired Ruy Finch, and Chester Wentworth left the Hawaii Sugar Planters Association to join the HVO. Howard Powers, Ray Wilcox, and their younger colleagues at the USGS facility on Adak in the Aleutians continued to map and investigate the Near Islands and Kiska, Little Sitkin, and others in the Rat Islands.[57] In California's Mojave Desert, Foster Hewett, Jerry Olson, Lloyd C. Pray, Daniel R. Shawe, and William N. Sharp completed detailed studies of the Mountain Pass area that outlined potentially mineralized areas of rare-earth deposits. They also discovered the Sulphide Queen carbonate body—with abundant rare-earth elements, principally cesium but also including some thorium, and barium—the largest such deposit yet discovered anywhere. Nelson Darton's 1:500,000 geologic map of South Dakota appeared in 1951, 3 years after his death. Branch geologists also completed some special mapping in Puerto Rico.

Wrather, Bradley, and Henry Joesting reorganized the Geophysics Branch in 1950. They kept James Balsley's Airborne Surveys and also Ground Surveys, where Gordon D. Bath replaced Joel Swartz in January. Aeromagnetic and aeroradioactivity surveys traversed some 43,000 miles in 12 States. Branch scientists used survey results to enlarge the known extent of iron-rich deposits in Minnesota's Vermillion Range, to trace additional buried structures in Michigan's iron areas, and, in conjunction with ground surveys, to extend Maine's known deposits of magnetite and associated manganese and to explore adjacent unmapped areas. The Ground Surveys Section also measured thermal gradients in ice and permafrost in Alaskan drill holes, determined the depths of aquifers, located highway materials, studied buried valley systems, and found areas favorable for lead-zinc and carnotite ores. On August 2, 1950, Wrather's Survey order[58] approved Bradley's shift of Frank Stead's Technical Planning and Development Unit (TPDU) from the Mineral Deposits Branch, where it had been since June 24, 1949, to the Geophysics Branch, as recommended by Joesting, Rove, and Stead. The TPDU, still wholly funded by the AEC but now with long-range functions more suited to the Geophysics Branch, provided Geologic Division field parties with gamma-ray logging units, portable field-survey units, airborne instruments, and other radiometric equipment and aided their use. The TPDU, renamed the Radiation Section, also developed geologic applications of radiometry and bases for interpreting radioactivity data,

including some applications beyond those required by the AEC program. The new Radiation Section, still led by Frank Stead, included geologists Kenneth G. Bell and Allen S. Rogers, Henry Faul (a paleontologist turned geophysicist), and physicists Kenneth A. Keisel and Arthur Y. Sakakura. The Branch's mathematical investigations included continuing work on the extension of resistivity tables for the flow of current in multiple-layered ground, methods of interpreting aeromagnetic surveys, and a report (in cooperation with the Naval Ordnance Laboratory) that showed that broad magnetic anomalies might extend to altitudes of 20 miles.

To support efforts on behalf of the DMA during 1950–51, the Alaskan Unit of the Alaskan and Foreign Geology Branch established a small working unit in Juneau. In a partial return to contributions made during World War II, USGS geologists in Alaska investigated strategic and other mineral deposits in the Glacier Bay area, the Haines-Skagway area, the Juneau gold belt, the lower Kuskokwim region, the Prince William Sound copper district, the Seward Peninsula tin area, and the Willow Creek district. They also looked at construction materials near the Alaska Railroad and Alaska Highway, along Cook Inlet, and on Kodiak Island. Farrell F. Barnes and Donald M. Ford studied cores recovered from USBM drilling in the lower Matanuska coal field and evaluated prospects for further development. Branch geologists also extended studies of the Aleutian Range's petroleum potential northward from the area around Iniskin and Chinitna Bays northeast to Tuxedni Bay. Don Miller and his colleagues continued fieldwork in the Yakataga and Katalla areas, and the USGS released a preliminary geologic assessment of the Yakataga oil field.[59]

Planning for the 1950 field season in NPR–4 continued on February 20, when Commodore Greenman, Colonel Kotick, Lewis MacNaughton, Walter English, Director Wrather, and USGS geologists George Gryc, Ralph Miller, and John Reed (Sr.) met as a part of a larger subcommittee and made specific recommendations for work by seven parties and three drilling operations. The Operating Committee, during its 12th regular meeting of April 19–21, approved test wells at South Barrow 4, Topagoruk 1, Meade 1, North Simpson 1, and Umiat (Ruby) 4 to 7 and under Lake Minga (Sinclair Lake) to investigate permafrost there. The Committee decided to defer drilling the East Simpson test well (the former Simpson 2) and suspend work on Oumalik 1, now down to 11,872 feet but with only shows of gas. South Barrow 4 pierced the gas-bearing zones as expected, Meade showed favorable indications of gas, and pumping tests on the Umiat wells showed that oil could be produced successfully from within the permafrost zone by cable-tool rather than rotary drilling; Umiat 4's potential was more than 75 barrels a day. By April, the USGS completed 52 1:96,000 photogeologic maps of quadrangles north of the Brooks Range and a series of 1:250,000 compilations for planning and regional studies, but Gryc and his colleagues agreed to suspend photogeologic work until William A. Fischer completed field studies as aids to interpreting more effectively the air photos. Fischer worked for the USGS in 1942–44, interpreted air photos in the Pacific as a Navy Lieutenant during 1944–46, and then mapped areas in NPR–4 with the Navy Oil Unit and uranium deposits in Western States. In 1950, he began directing the application of photogrammetric instruments and techniques to geologic mapping and related studies, initially of 1:24,000 quadrangles on the Colorado Plateau, by his photogeologists in George Gates' Alaskan Geology Unit. Gryc also reported a shift of the planimetric-map compilations from Denver to the Trimetrogon Unit in Washington, D.C. Greenman, who could not support work outside NPR–4 that did not contribute to that program, said that it would be shut down by the end of 1952 unless significant evidence indicated that a major discovery would be forthcoming or that such a discovery was made before then. In the summer, the Committee established at Fairbanks a joint staff, composed of the local leaders of each agency and organization, to review the program and its activities and advise the Operating Committee.

During the 1950 field season, the USGS Navy Oil Unit sent out seven geologic parties, the largest number yet, only one of which the USGS funded. Edward Sable's Party 1 mapped the Driftwood anticline. William Patton, Jr.'s Party 2 studied stratigraphy and structures in the Siksikpuk-Nanushuk area. William Brosgé's Party 3, supported by Navy helicopters, examined Lisburne Group exposures in the northern Brooks Range. Charles Whittington's Party 4, with "weasel"-tracked vehicles, mapped parts of the Carbon Creek and Ketik anticlines. G. Donald Eberlein's Party 5, also with weasels, looked at foothills in the area of the Killik and Etivluk Rivers and mapped the Aupuk anticline along the Colville. Irvin L. Tailleur's Party 6, also weasel-borne, investigated the structurally complex area between the Etivluk and Kiligwa Rivers. Thomas Dutro, Jr.'s Party 7 boated down the Nimiuktuk and Kugururok Rivers to the Noatak and its mouth. The six geophysical parties, five seismic and one gravimetric, concentrated detailed efforts in areas around Driftwood Creek and the Topagoruk and Meade Rivers and made reconnaissance surveys in the eastern and western parts of NPR–4.

The Operating Committee for NPR–4 met twice more during 1950 but thereafter convened under a new manager. When the Committee held an interim meeting in Fairbanks during September 12–14, Greenman introduced Captain Robert H. Meade, who led Seabee brigades in the Aleutians and the Philippines during World War II, as his new Deputy and prospective replacement as Director of Naval Petroleum and Oil Shale Reserves (DNPR). Greenman approved only minimum drilling to determine the productive limits of the Simpson and Umiat fields, limited geologic and geophysical work to fixing areas for completing drilling before the end of 1952, and forbade shallow drilling outside NPR–4, except possibly on the Gubik anticline. The Committee's 13th regular meeting, the last one chaired by Greenman, was held in Washington during November 27–December 1, 1950. Attendees agreed to drill 10 test wells on anticlinal structures, including one at Gubik to 5,000 feet. They recommended 60- to 90-day production tests at Umiat and four geologic and three geophysical parties for the 1951 season. Greenman's policy statement about NPR–4 on December 22 reported the Navy's approval of the exploration program for calendar 1951 but again cautioned that the work would be terminated in 1952 "unless very favorable results are obtained prior to 1 July 1951."[60] Gryc and William Fischer discussed specific structural features "revealed by the photogeologic work."[61]

Captain Meade, DNPR since December 1950, convened the Operating Committee's 14th regular meeting in Fairbanks on June 18, 1951; Reed again represented Wrather, and the USGS participants also included Gryc, Ralph Miller, and geologist Thomas G. Roberts, head of the city's USGS Arctic Coastal Area Subsurface Investigations' laboratory. Reed announced that Gryc would replace Ralph Miller as head of the USGS Navy Oil Unit when Miller succeeded Carle Dane as Chief of the USGS Fuels Branch in August. Attendees accepted estimates of about 70 million barrels of recoverable oil in the Umiat field, but they projected that a commercially viable pipeline would require 60,000 barrels per day from Umiat, and they knew that such a production rate could only be proved by tests in that field. The number of similar fields required to "justify the operation of NPR 4 as a whole"[62] remained open for discussion. The participants agreed to complete the test wells at Gubik (to 6,000 feet or into the objective sands), Kaolak, and Topagoruk. They recommended continued or new additional drilling near South Barrow and at Knifeblade Ridge, Titaluk, and Umiat. On June 22, Committee members reviewed the direct and byproduct results of the NPR–4 program for visiting Assistant Secretary of the Navy John T. Koehler, who especially noted the value of people learning "to work in the Arctic the year-round."[63] At the 15th regular meeting during November 5–8, the Committee wrote off Cape Simpson as a commercial prospect, reestimated oil reserves at Umiat at 30–100 million barrels, and suggested natural gas reserves at Gubik of about 900 billion cubic feet; the prospects at Umiat and

Gubik were partly tested by drilling in 1951. Committee members reviewed proofs of USGS Oil and Gas Investigations Map OM–126, "Geology of the Arctic Slope of Alaska," on three sheets at 1:1,000,000, by Thomas Payne and his colleagues. For 1952, attendees recommended drilling test wells at Grandstand, Weasel Creek, Wolf Creek, and two other sites; conducting geologic and geophysical fieldwork by three parties each; completing exploration to determine the full oil potential of NPR–4 and adjacent public lands; and continuing the program into 1953 at an additional cost of $8.5 million.[64]

During the 1951 season, the USGS Navy Oil Unit sent four field parties into NPR–4. Party 1's Samuel Keller and Robert Detterman examined the Shaviovik-Sagavanirktok Rivers area. Patton's Party 2, with William Brosgé and Marvin Mangus, studied the Okokmilaga and John Rivers part of the Brooks Range. Irvin Tailleur's Party 3, with Bion H. Kent and Hillard N. Reiser, worked south from the Colville River to the south side of the De Long Mountains. Sable's Party 4, with Thomas Dutro and Robert H. Morris, examined Driftwood Creek, the Colville's headwaters, and the Nuka River. The single geophysical party completed closure on the Gubik anticline. The USGS, by year's end and with William Fischer's direction, produced nearly full photogeologic coverage of NPR–4 at 1:96,000 and completed half of similar compilations at 1:250,000. By then, the USGS also finished 1:48,000 base maps for all of NPR–4.

Members of the Foreign Geology Unit continued studies in both hemispheres during fiscal year 1950–51. As part of USGS work in Latin America, John Dorr 2d, Philip Guild, Joel Pomerene, and Arthur Rynearson carried on their studies of iron, manganese, and other mineral resources of Minas Gerais in Brazil. Support for their efforts came from the State Department's Technical Cooperation Administration[65] (TCA) and the geologists of Brazil's Departamento Nacional da Produção Mineral. Dorr and his colleagues also helped to train additional Brazilian geologists and improve that country's facilities for exploration and research. USGS and Peruvian geologists examined the copper-lead-zinc deposits of Hualgayoc; they also observed the results of the May 1950 earthquake at Cusco. Harold Bannerman and William Johnston published USGS policy for training foreign geologists, and members of the unit advanced the in-service skills and experience of 19 young technicians from Brazil, the Dominican Republic, India, Mexico, and Pakistan.

In the Eastern Hemisphere, USGS scientists completed, continued, began, or planned investigations in Afghanistan, India, the Philippines, South Korea, and Thailand. On March 24, 1951, William Johnston returned from India, where he represented the Truman administration, Wrather and the USGS, and the Geological Society of America at the centenary of the Geological Survey of India (GSI) in New Delhi. While there, Johnston conferred with representatives of India's government and industry about Point Four geological projects in Orissa (Odisha) and elsewhere in the country, including the future detail of a geophysicist and an engineering geologist from the USGS. Johnston participated in the Indian Science Congress in Bangalore, in meetings at Lahore in Pakistan of the U.N. Economic Committee for Asia and the Far East, and in other conferences elsewhere in India and Pakistan. He also looked at the mining in India of coal at Bermo, iron at Naomundi, manganese at Nagpur, and mica at Koderma. In January 1951, George C. Taylor, Jr., also began investigating Orissa's groundwater resources. Geologist John A. Straczek, who led USGS field parties in Cuba and Peru during 1943–45 and 1947, now worked in India and continued earlier efforts by Dorr and other USGS geologists on the cooperative Point Four manganese project in Orissa. Unit members also completed, in cooperation with the Royal Department of Mines, a reconnaissance of Afghanistan's mineral deposits. David Andrews, Raymond Robeck, and David Vine returned to South Korea in September 1950 to complete field studies for their coal and mineral investigations sponsored by the Economic Cooperation Administration, finished their final reports, and then shifted in January 1951 to work on

the military geology of Korea. In July 1950, Ronald K. Sorem began aiding Earl Irving's ongoing investigations, in cooperation with the Philippine Bureau of Mines, of manganese deposits on the islands of Busuanga and Siquijor and other mineral resources in the Philippines. On November 7, Ceylon (Sri Lanka) signed an agreement to accept geologic and other aid under the Point Four Program. India and Pakistan signed a mutual full-trade pact on February 24, 1951. Andrews left Korea to study, during March–June 1951, Thailand's lignite deposits and to advise the Thai Government about their development and utilization.

When Glen Brown returned to work in Saudi Arabia in 1950, he encountered the changed relationships between Middle Eastern governments and Western oil companies later described by Daniel Yergin. Kuwait, with estimated reserves of 4 billion barrels, joined Saudi Arabia, with its 3 billion barrels of reserves, in 1946 in exporting oil. In 1947, Ashland, Phillips, and Sinclair formed the Independent American Oil Company to gain a concession in Kuwait's part of the Neutral Zone it shared with Saudi Arabia. J. Paul Getty's geologist[66] and Sheik Abdullah Suleiman al-Hamdan, still Ibn Saud's Finance Minister, signed a concession, at a higher price per barrel, in 1948 for the Saudi portion of the Neutral Zone. By 1950, oil from Middle East sources provided 17 percent of the world's total supply, including the amounts used by Europe, which increasingly consumed Middle East oil rather than its own coal, as promoted by the Marshall Plan. The Trans-Arabian Pipeline, completed by International Bechtel in September 1950, began delivering oil at Lebanon's port of Sidon (Saïda) in November. On December 31, Sheik al-Hamdan secured from Aramco a 50:50 split in oil revenues, the same agreement Venezuela gained from Standard of New Jersey and Royal Dutch/Shell in 1943.

In 1949, as Saudi oil exports continued to grow, Ibn Saud had asked the U.S. Minister in Jiddah for renewed American help in evaluating the mineral resources and water supplies of parts of the Kingdom outside the Aramco concessions. The King specifically requested that Glen Brown be assigned to lead the reconnaissance geologic mapping and related work, promising that his government would pay all costs and that Sheik al-Hamdan would sponsor and direct the effort. Brown had just completed for the Military Geology Branch a chromolithographic geologic map of Saudi Arabia, at 1:4,500,000, as the initial product of the MGB's "Basic Map Compilations" that included data gathered from the best available sources for use in planning for terrain studies. USGS geologist George R. Rozanski finished a hydrologic map of Egypt, at 1:2,000,000, as the initial one in the series. When the State and Interior Departments concurred in Brown's new assignment for 1950, arrangements were made with International Bechtel for housing, an office and storage space, vehicle maintenance, and other support. Brown immediately asked the Geologic Division to add Roy O. Jackson, a geologist and photogrammetrist, to the new project. Captain Jackson initially encountered Brown at Kharj in April 1945, while Jackson established a geodetic net to control the trimetrogon air photo strip his U.S. Army Air Forces (USAAF) squadron flew across the Arabian Peninsula. Jackson, working from the U.S. Mission at Ta'if in the Hijaz, also had met Bramkamp, Steineke, and other Aramco geologists, U.S. consul Parker Hart, and several Saudi officials.

American and British military maps proved inadequate for geologic compilation, so Brown and Jackson planned traverses and compiled data on test prints of the new air photos taken by the crew of Aero Service Corporation's modified B–17 as part of high-altitude, 1:60,000 photography of most of Asir Province and the coastal plain between Asir Province and the Red Sea. Brown planned to begin systematic mapping in Asir, north of the Kingdom's border with Yemen, fix geodetic positions there by astronomical observations, and measure elevations with barometers and Wild T–2 theodolites. After Aero Service finished the initial work in Asir, it gained photographic coverage aimed at producing controlled mosaics, at 1:100,000, for compiling geographic and geologic data. Brown and Jackson used

the summer of 1950 to organize and conduct a preliminary reconnaissance of the Jiddah area. They began more detailed fieldwork late that year in Asir and then gained the help of Sharif Kasem and Hisham Farouk, two young Saudi geologists in training, as field assistants for mapping in Asir. In 1951, the TCA and the U.S. Ambassador agreed to the establishment of a Point Four Mission in Saudi Arabia. Brown chaired the new Mission's Natural Resources Division, and Jackson served as his geologist. They planned to spend most of the next 2 years mapping the igneous and metamorphic rocks of the Arabian Shield and the sedimentary sequences of the Red Sea coast and planning for and drilling water wells. Brown, now also an informal adviser to the Saudi Minister of Agriculture and Water, helped to plan water-resources development in the major cities and groundwater irrigation in additional oases. In 1951, Brown's and Jackson's studies east of Riyadh led to test wells that discovered water in a Pleistocene channel under Wadi Hanifah, between Riyadh and Kharj. Similar investigations and drilling in Wadi Khulays, northeast of Jiddah, disclosed water in a sedimentary basin that produced sufficient supplies into the 1970s, when desalinization plants replaced these sources. Minister al-Hamdan then asked the USGS for a surface-water hydrologist to evaluate stream runoff in Asir and in the Red Sea littoral, assess groundwater recharge in the Riyadh area, and conduct related studies.

Frank Whitmore's Military Geology Branch, with continued financial and other support from the Army Engineers, and its Intelligence Division's Colonel Julian D. Abel, expanded its staff and operations to meet the needs of U.S. armed forces in Korea and elsewhere. Fritiof Fryxell took another leave of absence from Augustana College to return to the MGB for a year's service as its Assistant Chief. For the Natural Resources Section in Tokyo, MGB personnel continued in 1950–51 to supply special reports on terrain analysis and mineral and other natural resources. These reports included Charles Park's views on the potential of Japanese iron and manganese ores and assessments by others of the country's platinum-group metals, coal fields, fire clays, gold and silver deposits and mines, ore beneficiation, bentonite and bleaching clays, and the control and utilization of its rivers. Maurice L. Brashears, Jr., in evaluating Japan's groundwater, recommended institution-based investigations to remedy the harmful effects of overuse (particularly in the Nagoya, Osaka, and Tokyo areas), secure aquifer recharge, end surface-water wastage, and improve technology, operations, and management. Other specialists assessed coal fields in northern Honshu, Hokkaido's coals and terrain, and rock-phosphate resources in the Ryukyus; compiled routes and methods of evacuation in Korea; assessed the rehabilitation of Korean highway and railroad tunnels; looked at the sources of iron ore in Asia; and examined soils and cross-country movement in the Trans-Urals. Harold Burke completed evaluating Tinian's groundwater, while the rest of the Pacific Geologic Mapping Program's team prepared to extend their work to Guam, whose administration passed from the Navy to the Interior Department on August 1, 1950.

Members of the MGB also completed additional special reports abroad and at home. Branch specialists completed a 38-sheet, 1:250,000 terrain analysis of Korea and prepared studies, at 1:50,000 and 1:250,000, of the Chungju, Inchon, Seoul, and Taejon areas. Helen L. Foster assessed subsurface conditions at Pusan, Taegu, and Kimpo Airfield. Her colleagues also finished large-scale topographic maps of more of Korea's coal fields, prepared engineer-intelligence studies of Taiwan and its mineral resources, and evaluated the mineral resources of central Sumatra. Frank Reeves assessed Borneo's oil resources for the Interior Department, Maxim Elias identified for the Army Engineers sites in Turkey suitable for seismic arrays, and newly hired Cornelia C. Cameron mapped for the Navy Hydrographic Office the geology and terrain of the area around the port of Vólos in northern Greece. In Europe, MGB members analyzed England's Norfolk County for cross-country movement and suitable airfield sites. In the United States, they finished studies of

trafficability at the Army center at Big Delta, Alaska. William Davies and Selma Moses (who in 1951 married USGS geologist Lawrence D. Bonham) assessed military terrain near Pittsburgh, Philadelphia, Baltimore, and Norfolk. Their colleagues also classified Upper Kuskokwim lands in Alaska for the Conservation Division, investigated the geology of Alaska's Chena area for the Soil Conservation Service, and assessed ferrous and nonferrous resources in the 6th Army area in the West Coast States. Whitmore reemphasized the importance of using geological information in constructing military highways.

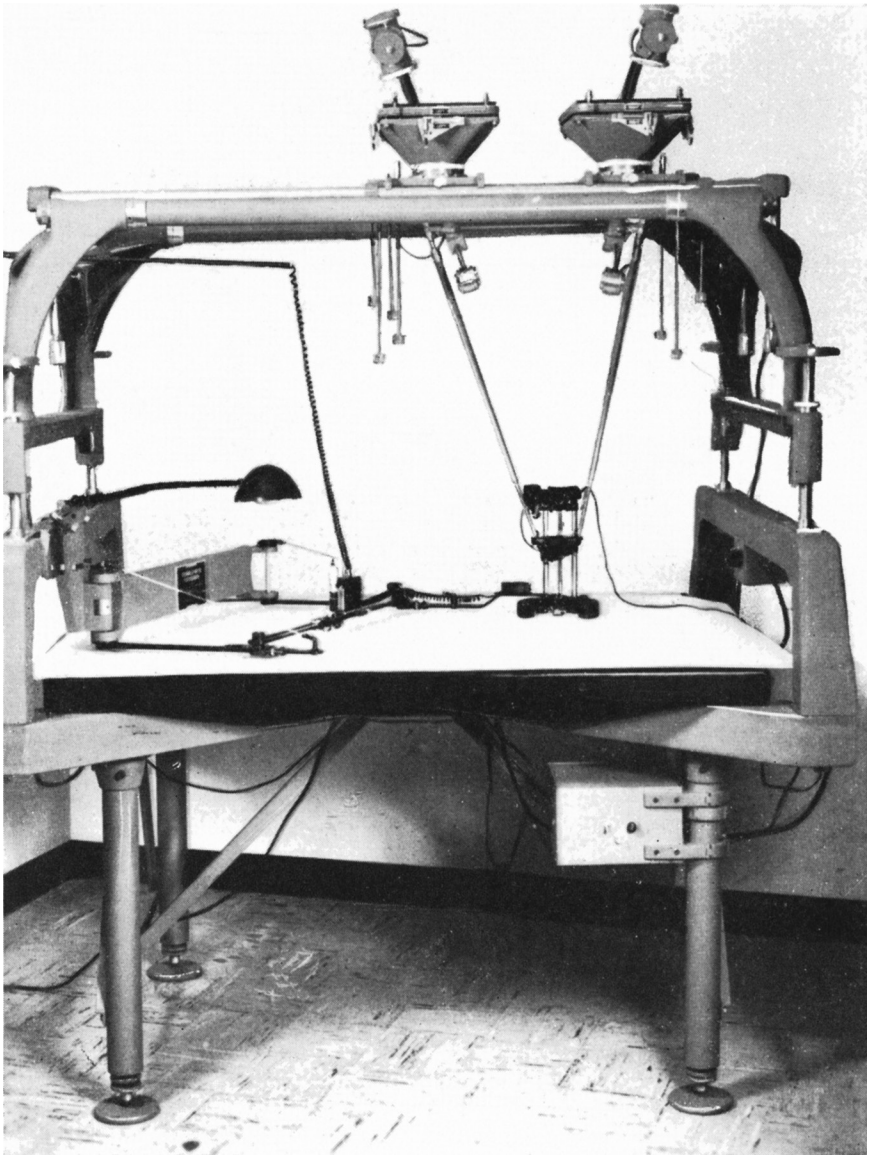
Gerald FitzGerald's Topographic Division drew on about $13,186,000 to support its surveys and mapping during fiscal year 1950–51, an increase of some $2.25 million over the previous year. Direct appropriations provided $7,521,000, or about 57 percent of all the funds received by the Division. The USBR continued as the chief contributor among the cooperating Federal agencies by increasing its funding by $453,000 to a total of $2.8 million, and the Army returned to making significant transfers by supplying $618,000, only $6,000 less than the sum provided by the Air Force. To these amounts, the Bureau of Public Roads and other Federal agencies added nearly $307,000, and States, counties, and municipalities transferred slightly more than $1,248,000, a decrease of some $55,000. Division managers decided to direct mapping operations during the next 6 years largely toward fulfilling the urgent requirements of the defense program, but, after reaching the maximum effort in the third year, they expected to give more attention to requirements for nonmilitary maps. In another long-range assessment, the Division appraised and classified almost 12,000 topographic maps prepared by other agencies and sold or distributed by the USGS through the end of calendar 1950. This review demonstrated that only about 25 percent of the country was adequately mapped to supply the current general needs of the expanding economy.

During 1950–51, USGS topographers mapped in some 3,700 quadrangles in all 48 States, and in cooperation with 26 of them, the District of Columbia, and Alaska, Hawaii, and Puerto Rico. When the fiscal year began, the Topographic Division continued to emphasize large-scale mapping of both militarily and economically important areas, but the Army Engineers in November 1950 provided funds for reorienting and expanding the Division's program to complete by 1957 the coverage of about 60,000 square miles of strategic areas in the conterminous United States and in the Alaska Territory. The Division began field revising its map coverage of the Hawaii Territory and accelerated all of its mapping in Alaska, where helicopters supported four field parties on the Alaska Railroad and the Richardson Highway. The Division adjusted work at its compilation and map-finishing facilities in the West to complete large-scale maps covering 30,000 square miles in Alaska and advance the 1:250,000-scale series more than 1 year ahead of schedule, while continuing the 1:63,360 mapping in the Territory's strategic heartland and high-priority coverage of parts of central and southwestern Alaska considered essential for the Alaska's economic development. Division topographers also completed about 61,000 square miles of new and revised mapping in the 48 States, nearly 2,000 of which were in the Kentucky 1:24,000 project, but coverage at 1:62,500 still formed the major part of the work. Mapping continued on 75,000 square miles of the Missouri River Basin. Work under contract, now authorized by statute, provided complete air-photo coverage of Puerto Rico as a basis for topographic and geologic maps of that island.

Photolithographic reproduction now formed nearly 94 percent of the published maps as the Topographic Division phased out copperplate engraving in favor of color-separation drafting on metal-mounted paper or other scale-stable media in preparing maps for reproduction that led to a tenfold increase in map products compared to the output in the years before World War II. The Division's Trimetrogon Section completed some 925,000 square miles of charting for the Air Force.

In other programs, the Division finished relief shading on 25 maps, including those of Chattanooga, Tennessee, the Great Smoky Mountains, and the Gunnison River-Black Canyon National Monument (now Black Canyon of the Gunnison National Park) in Colorado, as part of providing shaded-relief maps of areas of special physiographic interest. For the 1:1,000,000 International Map of the World, the Division published three additional sheets—Austin ([N]H–14), Cascade Range ([N]L–10), and Mississippi Delta ([N]H–15)—and continued work on Los Angeles ([N]I–11) and Savannah ([N]I–17) but suspended the preparation of additional sheets. The Division also issued 38 new sheets of the 1:250,000-scale transportation map of the United States—8 in Alabama, 9 in Louisiana, 15 in Nevada, and 6 in Ohio—while continuing to prepare sheets in 6 other States. On December 22, 1950, Wrather's Survey order[67] abolished the Map Reproduction Branch's Photographic Library and transferred its function, funds, collection, facilities, and staff from the Topographic Division to the Library in the Geologic Division, which had contributed 90 percent of the collection and wholly funded it since 1948.

Research and development by Topographic Division engineers in 1950–51, when James Buckmaster began serving as Acting Chief of the new Instrument



Photogrammetrists Harry Kelsh and Russell Bean and Bean's USGS research team combined to redesign Kelsh's 1943 stereoplotter after Kelsh transferred from the Department of Agriculture's Soil Conservation Service (now the Natural Resources Conservation Service) to the USGS in 1948. Their new modifications incorporated the use of wide-angle photography and eliminated the lamp houses that illuminated the full-sized diapositive area but also produced high heat. They devised compact and movable light sources to illuminate successive parts of the diapositive and a cam to adjust principal distance to correct camera-lens distortion. In 1951, the Trimetrogon Section modified a Kelsh plotter for use with trimetrogon photographs. Bean's team continued to improve the patented Kelsh plotter and it was widely used by the USGS and by industry during the 1950s and 1960s. (From Ray, 1956, fig. 12.)

Design Section, involved new methods using trimetrogon aerial photography to determine their accuracy and cost in compiling the 1:250,000 series and other standard maps. Another experiment prepared and tested photomosaics as plane-table compilation sheets in topographic field surveys. Division engineers also redesigned the Wilson alidade for additional use with glass plates, tested the rigidity of tripods for survey instruments, and studied the effect of the sun's radiation on precise levels. In Alaska, members of the Division experimented with extending vertical control inward from shorelines, and a contract airborne survey of about 78,000 square miles in the central part of the Territory tested the feasibility of obtaining ground elevations for topographic mapping by using the electronic Airborne Profile Recorder. Topographers in California, aided by portable radio-telephones used to synchronize observations, employed a direct-measurement electronic method similar to shoran while measuring horizontal angles to determine elevation points for supplemental control. Russell Bean and his research team refined the Twinplex system and its ellipsoidal reflector-55 (ER–55) projectors. The Twinplex, a compact, efficient, and versatile instrument also known as Bausch and Lomb's "Balplex," replaced the Multiplex units. In October 1950, the Division's Photogrammetry Section at Arlington began developing the Orthophotoscope,[68] in conjunction with Kelsh and ER–55 double-projection plotters, to convert conventional-perspective photographs to the equivalent of orthographic photos. The conversion eliminated image displacement due to camera tilt or ground relief and enabled accurate measurements of horizontal distances on the uniform-scale orthophotos.

Interest in the conservation and development of natural resources by the Truman administration and the 81st Congress produced legislation by November 1950. Congressional hearings in 1949 led to bills introduced to provide an accelerated mapping program and a comprehensive program for basic data about water. Both bills were reported out favorably by House committees in July 1950, but they died on the House floor, overwhelmed by the rush of defense-oriented legislation. In November, the House issued "A Program to Strengthen the Scientific Foundation in Natural Resources"[69] to supplement the records of the hearings. The report criticized the slow completion rate of national mapping and proposed a new program to finish the topographic mapping in 20 years and geologic coverage in 30 years. The proposed topographic mapping program would cost about $25 million annually, rising gradually from $18 million in fiscal year 1950–51 to $25 million in each of the fiscal years between 1953–54 and 1969–70. The geologic mapping effort would need $7 million in fiscal 1950–51 and would increase to $24 million in each of the years between 1956 and 1980. If Congress and the President continued appropriations only at the 1949 level, it would take 53 years to complete the topographic mapping and 158 years to finish the geologic coverage. The report included supporting programs for cadastral and control surveys, charting offshore areas, and mapping soils. It also proposed for the USGS a 20-year program, costing $50 million, to map federally owned parts of the Continental Shelf.

The House's report also labeled as inadequate and fragmentary the nature of Federal investigations of the Nation's water resources and noted six principal problems. First, no satisfactory determination had yet been made of the overall quantities of precipitation in each catchment area or drainage basin. Second, available precipitation records had not yet been used to determine volumes of water that could serve as a starting point for systematic accounting of water resources. Third, measurements of stream runoff were restricted principally to the larger rivers and streams. Fourth, measurements, or even identification, of the location and character of subsurface water movements remained almost completely lacking. Fifth, evapotranspiration continued to be the area of greatest deficiency in accumulated data and research. Sixth, the executive branch had failed to coordinate the efforts of its agencies engaged in measuring and investigating the various features

of the hydrologic cycle and had not delegated responsibility for appraising and interpreting the measurements and other hydrologic facts collected. At present, the report noted, the USGS program of groundwater studies was almost completely tied to projects for which funds from States, counties, and municipalities were available on a matching basis. This arrangement left few, if any, monies for groundwater research before the planning stages of the extensive water-resource projects financed by the Federal Government. The work of the basic-data-gathering agencies, the report continued, was so completely absorbed in recording the measurements and publishing the raw data that they could pay comparatively little attention to appraisals and interpretations by the experts who knew most of the limitations and possibilities of the data they collected. Especially important, the report urged, was keeping those basic-data agencies free from bias or influence. It was also vital that they have the responsibility to provide dependable interpretations of the quantity, quality, and availability of the Nation's water resources.

On December 11, 1950, the President's Water Resources Policy Commission issued Volume 1 of its report on "A Water Policy for the American People." Echoing John Powell and his like-minded successors, Morris Cooke and the other Commissioners concluded that the river basin should be the fundamental unit for comprehensive planning in water and related land-use issues. Their recommendations included those for program planning, evaluating proposed water-resources developments, gathering basic data, financing, designing reimbursement procedures for recovering a portion of the benefits resulting from public expenditures, managing water resources, reclaiming lands, ensuring water supplies, tracing sources of pollution, facilitating transportation on waterways, securing and expanding hydroelectric power, preserving and enhancing fish and wildlife resources, and recognizing and expanding recreational potentialities. Water-resources investment should aim at achieving "the maximum sustained use of lakes, rivers, and their associated land and ground water resources to support a continuing high level of prosperity throughout the country." Congress should establish national objectives including "the safeguarding of our resources against deterioration from soil erosion, wasteful forest practices, and floods; the improvement and higher utilization of these resources to support an expanding economy and national security; assistance to regional development; expansion of all types of recreational opportunity to meet increasing needs; protection of public health; and opportunity for greater use of transportation and electric power."[70] If the reorganization of the field of natural resources were not carried out according to the Hoover Commission's recommendations, the Cooke Commission suggested that Congress set up separate river-basin commissions for each of the major basins not yet so covered, with independent chairmen appointed by the President, to coordinate the surveys, construction, and operations therein of the Federal agencies. Volume 3 of the Cooke Commission's report, transmitted on February 5, 1951, treated water-resources law.[71] Volume 2, following on February 19, examined the possible effects of the proposed policies on California's Central Valley and on nine other river basins—the Alabama-Coosa, the Colorado, the Columbia, the Connecticut, the Missouri, the Ohio, the Potomac, the Rio Grande, and the Tennessee.[72]

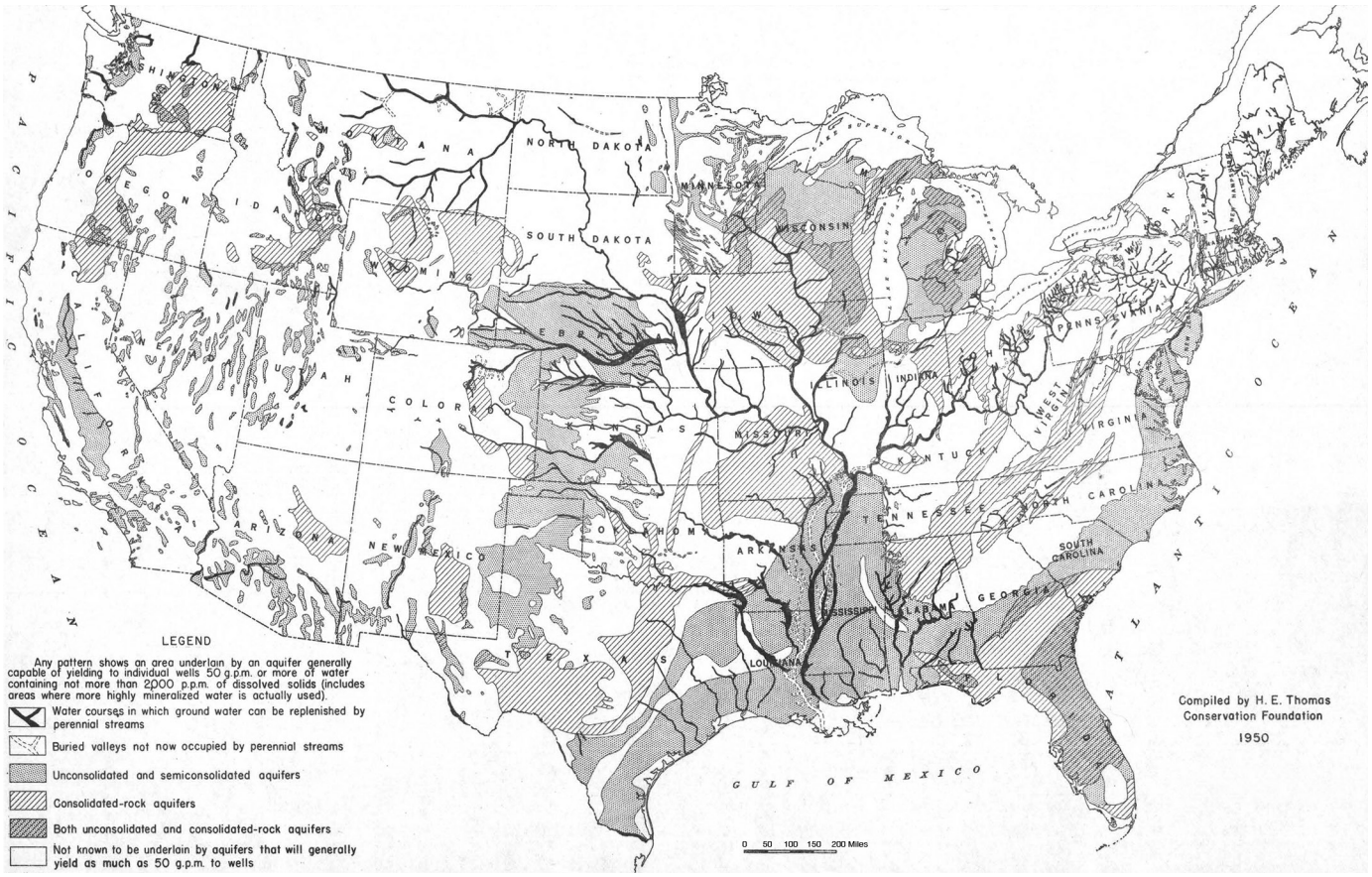
The Water Resources Policy Commissioners remained clear about the need for basic data in water-resources studies. Congress should provide ample funds, they recommended, for compiling and analyzing the necessary basic information, including climatic, economic, geologic, hydrologic, land, and soil data, to assure sound and comprehensive, multiple-purpose basin planning. All basin recommendations should carry a precise statement as to the adequacy of the data upon which they were based, and managers should be prepared to withhold approval of recommendations in areas with inadequate data. "A survey program designed to supply the country with full geological and hydrological knowledge of its surface and groundwater resources,"[73] the Commissioners urged, should be initiated immediately, with

ample funding for the early compilation of essential information and continued thereafter to meet all the requirements of basin programs. A comprehensive annual program of all water used and requirements in relation to available sources of supply should be prepared and reported for regions and localities on a basis permitting 10- and 20-year running forecasts of requirements and supply. A survey also should be undertaken to evaluate the possibilities of and provide a program for developing the water now being consumed in the West by cottonwoods and other allegedly unneeded and water-loving plants whose roots tapped the water table or the capillary fringe above it. The Commissioners also recommended setting a 10-year interval within which "a reasonable program for cleaning up the Nation's polluted waters"[74] could be accomplished, appropriating sufficient funds for administrative and regulatory activities of the Public Health Service's Division of Water Pollution Control, and making available ample funds for Federal loans to municipalities.

The Commissioners predicted dire times ahead for the Nation's water resources unless Congress and the President acted promptly to solve current and projected problems. They asked the Federal Government to "recognize that, with growth of population, urban concentration, industrialization, and the need for an expanding agricultural base, availability of fresh water may soon become a limiting factor in the expansion not only of the Nation's arid and semiarid regions but also of our entire civilization." The Government, they urged, "should, therefore, accept the responsibility for large investment in broad research programs designed to expand the available supplies of water."[75] The Commissioners recommended that the policies they offered be incorporated in a single statute. Truman endorsed their report on March 14, 1951, and asked the Budget Bureau to review and suggest legislation; no general bill followed but many of their proposals were adopted in other ways.

The Water Resources Division during fiscal year 1950–51 shifted the emphases of many parts of its program to meet defense needs more effectively. Carl Paulsen's Division amassed nearly $11,503,000 to support salaries and operations during fiscal 1950–51, an increase of $1.8 million, or almost 19 percent more than the total available in 1949–50. Of this sum, direct appropriations provided $5,156,000, a $1.2 million increase. About $6,347,000, or 55 percent, came from outside sources. States, counties, and municipalities supplied more than $3,065,000, nearly $296,000 more than the previous year. The USBR, as before, led the Federal agencies in transferring funds of about $1,469,000, an increase of $78,000. The Army shifted $885,000, the Navy raised its total from $1,200 to nearly $48,000, and the Air Force resumed its contribution with about $13,000. The BIA transferred more than $106,000, an increase of $61,000 from the previous year. The AEC, the State Department, and the Tennessee Valley Authority (TVA) all reduced their funding, but only by a total of $37,000. Increased or new transfers of $108,000 from the Bonneville Power Administration, the ECA, and other Federal agencies more than made up those losses. The direct appropriation for soil and moisture conservation rose by more than $5,000 to $40,500.

Demands on the Water Resources Division for basic streamflow data continued to increase, and other domestic issues also continued to command the Division's attention. The floods of January 11–25, 1951, covered 1 million acres of the Missouri River Basin and caused $1 billion in damage; lands in Illinois, Kansas, Missouri, and Oklahoma were especially hard hit. The Surface Water Branch added about 100 gaging stations during the year to raise its total in operation to more than 6,300 sites, 52 of them in Alaska, observed by workers based at some 150 field offices and in cooperation with more than 170 Federal, State, and local agencies. The Branch introduced a new current meter for use under ice and the B–50 reel that automatically computed the meter setting. The Branch began compiling, from annual reports in USGS Water-Supply Papers, all U.S. monthly and annual records



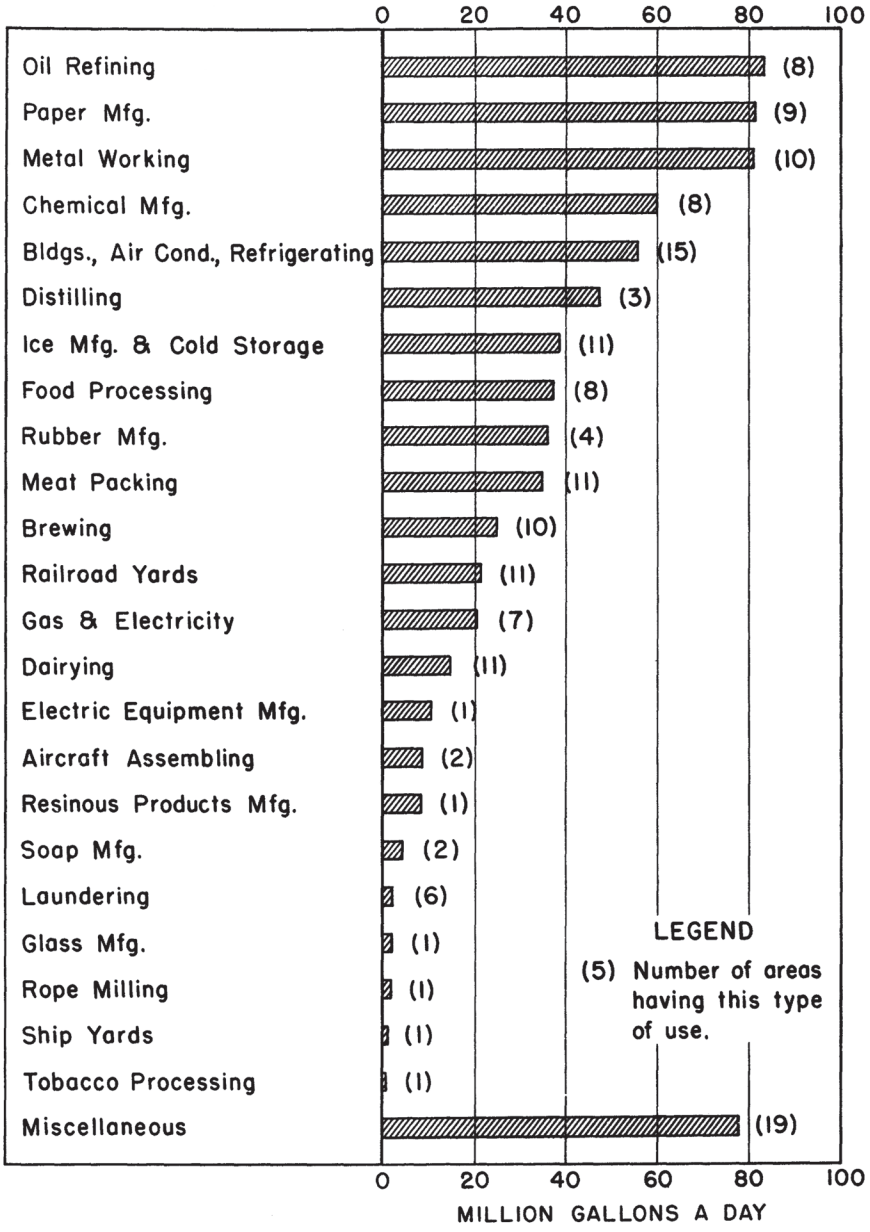
This map (originally at 1 inch = 300 miles) shows U.S. areas underlain by aquifers "generally capable of yielding to individual wells 50 g.p.m. [gallons per minute] or more of water containing not more than 2,000 p.p.m. [parts per million] of dissolved solids." Harold Thomas compiled this map in 1950 from data supplied by the USGS, other Federal agencies, and State agencies. Thomas' map shows several types of aquifers and more detail than Oscar Meinzer's 1939 map of four principal groundwater regions and their subordinate provinces (see Rabbitt, M.C., 1986, p. 401). In postwar years, the USGS continued its comprehensive studies of U.S. aquifers and the perennial streams that replenished them to supply the growing needs of industrial, municipal, and rural users. (Quotation and Thomas' map from McGuinness, 1951, fig. 17; see also Thomas, 1951.)

of streamflow during 1888–1950. Walter Langbein and Ethel M. Wilson (later Coffay) determined that up to September 30, 1946, the USGS collected some 95,000 stream-year records and 63 percent of the gaging stations established by the agency still were operating. Information about streamflow characteristics remained one of the important criteria in selecting several sites for new atomic-energy plants.

The Division's report on the estimated use of water in the United States during 1950 showed that withdrawals from streams, lakes, and underground occurrences totaled about 170 billion gallons each day, exclusive of the 89 million acre-feet of water used in developing power, or about 145 gallons per person per day. Industrial use averaged 77 billion gallons each day from private sources, including some brackish water. Rural domestic and stock supply consumed on average another 3.6 billion gallons per day. The Federal Government used the Division's water data in determining what supplies to provide from the public domain for watering stock. New supplies of water from wells, springs, or ponds, developed from exploration by the Division, at the request of the BLM or other agencies in charge, brought tens of thousands of acres into use for grazing. In many other areas, these data helped to improve old and uncertain supplies. The more evenly distributed use of water on public lands increased its value by diffusing concentrations of grazing and thereby reducing erosion. Division studies led to a better understanding of the effects of rainfall, vegetation, soil properties, and land use on rates of erosion and sedimentation to prevent further destruction of productive valleys devastated or being destroyed by systems of large gullies that impaired the land for grazing and irrigation, and also drained shallow groundwater and carried sediments into rivers that emptied into reservoirs.

The development of U.S. groundwater resources accelerated during 1950–51. As in World War II, the proportion of groundwater studies related to

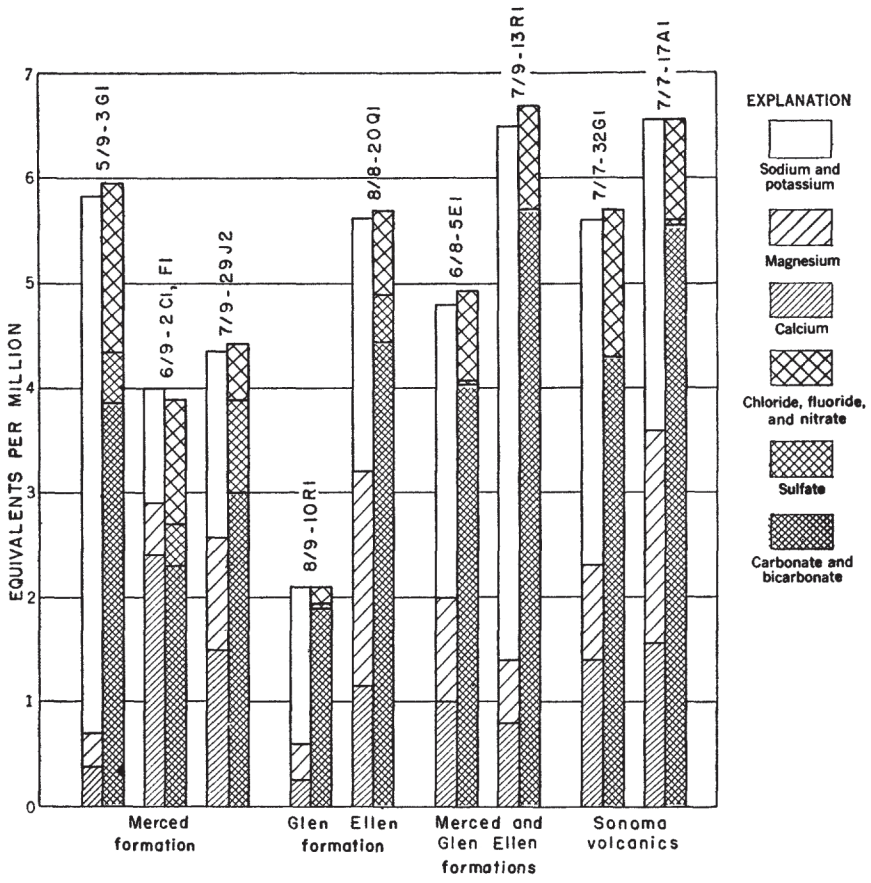
This chart shows the use of groundwater in millions of gallons a day (mgd) by industries in 20 selected metropolitan areas in the United States during 1945, not including water from municipal suppliers. The numbers in parentheses represent the areas that include oil refining (8) and the other industrial users. Accompanying maps showed the amounts of groundwater used each day for irrigation and consumed by industries and municipalities during 1945. California used more than 2,000 mgd for irrigation and slightly less than 500 mgd for municipalities. Industries in New Jersey used 500 mgd; those in Indiana and Ohio, only slightly lesser amounts. Texas, at about 100 mgd, led rural use in ways other than for irrigation. California led the Nation in the total use of groundwater, followed by Arizona and then Texas. (From McGuinness, 1951, fig. 16.)



national-defense activities increased at the expense of the other investigations underway. Most of the new defense-related studies, as before, also provided data expected to be useful in future projects, and many of them involved expanded research that yielded improved techniques applicable to groundwater problems of all types. Among them, hydraulic engineers adapted sonic methods of measuring depths to determine the thickness of earth materials and rock sequences. Groundwater personnel improved their equipment by developing for truck-mounting a set of compact and light-weight electrical well-logging instruments, adapting a sensitive electrical temperature-measuring instrument to show the direction and velocity of water movement in drilled wells, and developing an electrical tape gage that replaced batteries with an electrical current completed between dissimilar metals when the electrode contacted the water.

Studies by the Ground Water Branch involved cooperation with nearly 100 Federal, State, and local agencies. Harold Thomas' book "The Conservation of Ground Water," published in 1951, described occurrences and effects of use and a

detailed national map of productive aquifers and potential yields to wells. Branch specialists extended their studies of mine-drainage problems, begun several years earlier in Michigan, to new investigations in Arkansas, Minnesota, and Tennessee. They hoped that their fundamental research, supported by a newly activated Research Section, on the movement of water in and adjacent to ore-bearing formations would provide cheaper and more effective methods of dewatering mines and enable the development of ores that then could not be worked economically. They also extended their research on the use of underground reservoirs in disposing of radioactive materials, spent brines, and other waste products. Fieldwork and geochemical experiments by Margaret D. Foster and her colleagues demonstrated that high bicarbonate concentrations in groundwater in the Atlantic Coastal Plain were due to ion exchange between the water and clay minerals. A study of microfossils from wells near the Brookhaven National Laboratory on Long Island yielded information about the character and continuity of the containing clay stratum, data important for evaluating the recharge and dependability of the water supply in the sand and gravel under the clay and for determining how radioactive wastes might be disposed of safely. Specialists also began an investigation in New Jersey of the relation of groundwater recharge and streamflow to soil and vegetation. They reported on the use of cyclic fluctuations of water levels in observation wells, such as those caused by ocean tides, in computing the hydraulic properties of water-bearing formations previously based largely on analyses of data gathered in controlled pumping tests of wells. They developed, using similar methods, a technique for computing hydraulic properties from the results of bailing tests made in wells where the depth of water or the cost involved precluded conventional pumping tests. For the AEC, the Branch specialists also studied groundwater resources in New Mexico's Valle Grande; they located much stored water in the volcanic sediments but only a small perennial supply in the area.



This graph shows the variations in chemical composition of the calcium-magnesium-bicarbonate water sampled from the principal wells in the Santa Rosa Valley of northern California. Well numbers are given above the columns. In postwar years, USGS hydrologists increasingly studied the chemical quality of groundwater throughout the rapidly developing American West. George T. Cardwell, cooperating with colleagues in California's Division of Water Resources during 1949–51, examined the geology, groundwater resources, and recharge capabilities of the 450 square miles of the Santa Rosa and Petaluma Valleys in Sonoma County, north of San Francisco Bay. Groundwater occurred in the Merced, Glen Ellen, and Sonoma Formations, a Neogene sequence of, respectively, marine sedimentary, continental sedimentary, and volcanic rocks. (From Cardwell, 1958, fig. 12.)

As part of the Ground Water Branch's international activities, George C. Taylor, Jr., after completing work in Thailand, spent 6 weeks during June–July 1950 planning a long-term cooperative program in hydrology with the Geological Survey of India. Taylor visited locales in Madras (now Tamil Nadu), a port on the Gulf of Kutch, and areas in Uttar Pradesh. Taylor returned to India in January 1951 to begin the technical-assistance program to further train GSI personnel; he and his trainees explored, mapped, and sampled groundwater resources in 22 areas on the Ganges Plains. Some of his Water Resources Division colleagues in the United States helped to train hydrologists from Canada, Haiti, India, Japan, and the Union of South Africa.

Scientists in the Quality of Water Branch's 13 laboratories, including one newly established at the University of California at Davis (UCD), determined the chemical content of nearly 50,000 samples and the nature of sediments in more than 125,000 samples during fiscal year 1950–51. Branch members began collecting daily and intermittent samples of surface water at a number of additional sites at streams in the West to follow mineral-content trends to ensure continued success in operating existing irrigation projects. The Branch founded a section during the latter part of fiscal 1949–50 to investigate the quantity and quality of water required to produce various manufactured products and assist the planning for and preparation of reports on the water resources of specific areas. Its members collected information on the quantity of water needed to yield a given unit of production, the chemical content of water permissible for certain industries, and the variation in the way water was applied within manufacturing or mining activities. The unit began its now more urgent work with the steel industry. Information obtained from industrial plants revealed that the basic industries producing the initial materials for later fabrication, such as gasoline, paper, plastics, rubber, and steel, required the largest volume of water, both for the individual plant and for a given tonnage or unit of production, and required water having specific chemical qualities and temperatures. Fabrication processes needed much less water, in some plants little more than the volume used for workers' sanitation.

For fiscal year 1950–51, Harold Duncan's Conservation Division received a total of $1.2 million for classifying lands and supervising mining and oil and gas leases, an overall increase of $67,000, or nearly 6 percent more than in 1949–50. Increases in direct appropriations of $1,950 for land classification and $94,000 for mineral supervision, and $2,800 transferred from the PAD, more than replaced the reduction of $30,000 for these functions in the total funds formerly transferred by the USBR, the Navy, and other Federal agencies, and the end of funding by the BIA and the States, counties, and municipalities.

Field and office work by all four of the Division's Branches again grew during 1950–51. The Mineral Classification Branch's case load increased by 700 items to 16,600 because the public became increasingly interested in acquiring Federal land for settlement or for prospecting for oil and gas resources, activities that more than offset a decline in applications for coal, phosphate, potassium, and sodium. During the year, the Mining Branch supervised 1,250 mining properties in 29 States and Alaska. Minerals produced from the monitored lands rose by nearly 5.5 million tons to over 19.1 million tons and generated royalties of about $3.8 million, some $956,000 more than in the previous year. The production of coal from the public lands, including the former Chickasaw-Choctaw lands in Oklahoma purchased by the Federal Government on May 1, 1949, rose by nearly 1.5 million tons, an increase achieved despite greater competition from other fuels that reflected the increased industrial tempo. Potassium production also rose after the prolonged strike in 1949. Indian lands in Arizona, New Mexico, and Utah produced substantial tonnages of uranium-vanadium ores. The Oil and Gas Leasing Branch supervised more than 38,900 properties on about 29.8 million acres of public lands,

increases, respectively, of 34 and 26 percent from the totals in 1949–50. Fuels produced from public, acquired, and Indian lands yielded total royalties of nearly $34.8 million, a gain of nearly $5.9 million. In California's NPR–2, similar production from 258 wells, 4 more than in 1949–50, provided royalties of about $913,000, a $32,000 loss, and those from the Army's Rio Vista gas field added another $380,000. The Water and Power Branch supervised the construction and operation of nearly 840 power projects under licenses from the Federal Power Commission or permits and grants from the Interior Department, or in cooperation with the BIA, representing an increase of almost 190 projects compared to 1949–50. Branch classifications increased the power-site reserves in 23 States and Alaska by 4,500 acres to a total of more than 6.8 million acres. The Branch completed nearly 5,160 hydraulic and mineral classifications, 1,205 more than in 1949–50. In addition, the Branch finished topographic surveys of 15 sites for dams and reservoirs and more than 120 miles of river channels.

On September 9, 1950, as the USGS program divisions increased their efforts for national defense, President Truman announced he intended to substantially increase U.S. ground forces in Europe by adding units to the two divisions already there. The North Atlantic Council, meeting in New York City during September 12–19, agreed to view any attack on the German Federal Republic as an assault on Council-member countries. The representatives decided to resist Soviet aggression as far east as possible, to increase their forces in and revise their occupation laws for West Germany, to relax their controls on its economy, including ending limits on steel production, and to allow the West Germans to begin formal diplomatic relations with other nations. The North Atlantic Treaty Organization's augmented forces also would someday include a Bundeswehr. The Soviet Union responded to these decisions by sending Vyacheslav Molotov to Prague to meet, during October 20–21, the foreign ministers of Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, and Romania. Molotov denounced NATO's new policies toward West Germany and again called for a peace treaty and the unification of the two Germanys. On October 24, French Premier René Pleven proposed a European force of 100,000 men, within NATO, to defend the continent, including West German components up to battalion level. In November, NATO's military representatives began a policy of restraining the Soviet Union by combining the nuclear weapons carried by U.S. strategic bombers, Euro-American ground forces supported by European tactical airpower, and U.S.-European naval forces. In December, France agreed to America's request for the participation of West German troops above battalion level in any European defense force established under Pleven's plan.

On September 21, 1950, two days after the Council's meeting ended, George Marshall reluctantly succeeded Louis Johnson as Secretary of Defense, who left on September 19, a day after Truman asked for Johnson's resignation. Marshall, although concerned that the time he spent in China and some of his other past service might give Republicans additional ammunition to use against Truman, assumed responsibility for rebuilding U.S. armed forces and, with the Joint Chiefs of Staff (JCS), for planning how best to expel the North Koreans from South Korea and implement the detailed recommendations in U.S. National Security Council Directive 68/2 (NSC–68/2) of September 30.

While the North Atlantic Council deliberated, U.N. forces in South Korea exchanged defense for attack by invading tide-swept Inchon, Seoul's port, while other units broke out of the Pusan Perimeter. The North Koreans' final assaults there began on September 13 but sputtered out against the Perimeter's defenses. The Army and Marine divisions of the U.S. Army's newly reactivated X Corps assaulted Inchon in Operation Chromite on September 15, with General MacArthur observing from *Mount McKinley*, as the 8th Army counterattacked in the south. General Bradley, who received his fifth star on September 20, and the JCS doubted

the wisdom of MacArthur's plan, but General Eisenhower supported the Inchon landing and it succeeded brilliantly, in part because Kim Il Sung ignored Chinese warnings and failed to order the harbor and its approaches mined. MacArthur's troops recaptured Kimpo Airfield and then took Seoul on September 26. On that day, they also linked up north of Osan with 8th Army units coming up from the southeast. The 8th Army and X Corps completed the destruction or scattering of the North Korean divisions and drove some of their remnants north across the 38th parallel and completed the U.N.'s original mandate to liberate South Korea. MacArthur and Syngman Rhee recommended immediate pursuit across the border to complete the North Koreans' defeat, occupy their country, unite the peninsula under Rhee's rule, and demonstrate that Communist domination was not inevitable. On September 27, Truman, as recommended in NSC–81/1, and supported by Acheson, Bradley, Eisenhower, and Marshall, authorized operations north of the 38th parallel.

On September 30, 1950, Premier Zhou Enlai, encouraged by Stalin, who supplied knowledge from his spies that Truman likely would not authorize using atomic bombs against the People's Republic of China, suggested to India's Ambassador that the People's Liberation Army might have to intervene on behalf of the North Koreans. Mao decided to do so on October 2, the day after ROK units crossed the 38th parallel. The President and the JCS continued to hope to avoid a confrontation with mainland China, but MacArthur and Acheson assured them that the Chinese were bluffing and, if they were not, they would be soundly beaten. U.S. forces crossed the parallel on October 9 and moved north toward Pyongyang. MacArthur withdrew X Corps and sent it by sea around the peninsula to land at Wonsan and move north and northeast. Communist Chinese "volunteers" began to enter North Korea as Zhou denounced the transgression and declared that China would act. Truman and MacArthur, meeting briefly at Wake Island on October 15, talked alone and then together with Bradley, Pace, Harriman, Radford, and others, as U.N. forces closed on Pyongyang and Chinese forces led by General (later Marshal) Lin Piao (Lin Biao) began crossing the Yalu River into North Korea. MacArthur, backed by the Central Intelligence Agency's (CIA's) assessment, again assured Truman that the Chinese Communists would not enter the war unless U.N. forces attacked across the Yalu River into Manchuria. MacArthur wished to "unleash" Chiang's forces on Taiwan against both North Korea and mainland China. Truman's and MacArthur's joint communiqué from Wake only papered over their real differences in strategy.

On November 1, 1950, two weeks after Truman's meeting with MacArthur on Wake Island, violence of another kind came to the President's doorstep when two Puerto Rican separatists tried but failed to enter Blair House to assassinate him. Truman had signed a statute on July 3, to provide "for the organization of a constitutional government by the people of Puerto Rico"[76] to enlarge the island's self-governing authority. When that status did not appear promptly, the separatist gunmen attacked. In June 1951, Puerto Ricans voted for self-government by a popularly elected governor and a bicameral legislature. Congress and the President approved the Commonwealth Act in July and, a year later, the Commonwealth's constitution adopted by its people for a free polity in association with the United States.

United Nations' forces, now including units from Australia, Britain, The Netherlands, the Philippines, Thailand, and Turkey, occupied Pyongyang on October 20, 1950. Four days later, when the Joint Chiefs did not object, MacArthur ordered a general advance to the Yalu River. Units of the X Corps reached the Yalu on November 21, and MacArthur ordered an end-the-war offensive on the 24th. Communist Chinese forces continued to flow across the Yalu; they began fighting alongside North Korean units on October 26 and MacArthur publicized their presence on November 5, but he grossly misrepresented their numbers. Communist Chinese

forces, now more than 300,000 men, began attacking the divided and overextended U.N. troops on November 25. The Chinese "volunteers" lacked the U.N.'s armor, artillery, and air-to-ground support, but they were mostly disciplined and veteran light infantry, victors over the Japanese and the Nationalist Chinese. During October, other Chinese Communist units invaded and occupied Tibet. On November 30, as the Chinese Communists continued their offensive in North Korea, Soviet Ambassador Malik vetoed a resolution in the U.N. Security Council that called on the Chinese to withdraw from North Korea and promised to safeguard their common border. The Chinese forces' attacks shattered MacArthur's confidence, forced the evacuation of X Corps from Hungnam and Wonsan, drove the 8th Army south from the Yalu, retook Pyongyang, and recaptured Seoul in January 1951.

The Truman administration also increased its aid to the French counter-insurgency war in Indochina. A U.S. Military Assistance and Advisory Group[77] arrived in Saigon on September 8, 1950, to help support Bao Dai's Republic of Vietnam. In mid-October, France announced America's promise to provide more military and related funds and equipment. On December 23, an agreement among the United States, Cambodia, France, Laos, and South Vietnam recognized their common interest in supporting freedom and its principles in the region. The agreement led to providing France with financial aid to help its forces reassert control over all of the former French Indochina. As the multinational French Expeditionary Corps fought the Viet Minh in Tonkin, protests grew in France, and Bao Dai's political and military support eroded in Saigon and in Vietnam's countryside. The Viet Minh broke the French cordon defenses in Tonkin's northern and northeastern border areas in October 1950, facilitating increased support from China. During January–February 1951, when Giáp's premature offensive failed to penetrate the French perimeter around Hanoi and the Red River (Sông Hông) delta, his troops reverted to guerrilla tactics. The United States sent $500 million in aid to France in 1951.

Truman, continuing his administration's response to the disaster in Korea and concerns for containment elsewhere, consulted with allies and advisers and then acted during November 1950–March 1951 to strengthen America's defense and economy. On December 1, the President asked Congress to provide in fiscal year 1950–51 an additional $16.8 billion for the Defense Department and another $1 billion for the AEC. A week later, Truman and British Prime Minister Attlee met in Washington to discuss military and political policies in Korea and in Europe, as Britain neared the end of its Marshall Plan aid on January 1. Early in the next year, Attlee announced a 3-year program for rearming Britain that would cost £4.7 billion. On December 16, Truman declared a state of national emergency, established within the Executive Office of the President an Office of Defense Mobilization (ODM), and appointed Charles Edward ("Electric Charlie") Wilson to lead it. The DMA and other new agencies followed the ODM early in 1951. General Order No. 2 by Eric A. Johnston, the Economic Stabilization Administrator, created on January 24 the Office of Price Stabilization (OPS), whose Director's position Truman authorized on November 30, 1950, pursuant to the Defense Production Act; he appointed Michael V. DiSalle to the post.

Another Executive order established the Defense Materials Procurement Agency[78] (DMPA) on August 28, 1951, to increase the production and procurement of raw materials vital for national defense, and Truman made Jess Larson its Administrator. Larson's DMPA quickly delegated its exploration functions to Interior Secretary Chapman, who passed them on to the Defense Minerals Administration and, on September 11, added "Exploration" after "Minerals" to the DMA's name. On November 27, the DMEA's operating committee held its initial meeting to begin reviewing applications from industry for contracts, grants, and loans to discover and mine strategic and critical minerals. More than a month earlier, on October 10, Truman signed the Mutual Security Act to "maintain the security and

promote the foreign policy and provide for the general welfare of the United States by furnishing assistance to friendly nations in the interest of international peace and security." The new statute authorized more than $7 billion in "military, economic, and technical assistance"[79] for NATO countries or other crucial European nations like Greece. Funds also went to Iran, Israel, Palestine, Turkey, countries elsewhere in the Near East and in Africa, the Philippines, South Korea, Taiwan, and the American Republics. The act enabled detailing U.S. personnel to foreign governments and international organizations. The law also provided $55 million "to promote increased production, in areas covered by this Act, of [strategic] materials in which the United States is deficient,"[80] under authority of 1948's Economic Cooperation Act. The new statute abolished the ECA and transferred its functions and personnel to a new Mutual Security Agency (MSA), in the Executive Office of the President. Truman nominated and the Senate promptly confirmed Averell Harriman who also served on the NSC, as the MSA's Director. The MSA began operations on December 31.

During these months, Truman also acted to strengthen science's role in supporting the Nation. Truman announced on November 2, 1950, his selections for the National Science Board. The 24 persons chosen for the NSB, as Merton England recorded, were drawn nationwide from 20 universities and colleges, 2 institutions that provided monetary grants, and 2 industrial firms. The NSB also included two women (one of whom was a Nobelist) and two African-Americans. Detlev Bronk, James Conant, Lee DuBridge, Donald McLaughlin, and the other members of the National Science Board, except "Electric Charlie" Wilson, met with Truman and John Steelman at the White House on December 12. There, they chose Conant as Chairman, and a nine-member executive committee chaired by Bronk, and discussed what they wanted in a director. On December 18, William Golden, a former banker and now Special Assistant to the Bureau of the Budget's Director, reported to Truman recommendations on how best to mobilize science in support of the conflict in Korea. In 1949, Vannevar Bush recommended establishing a new office of scientific research and development to deal with the next war, one that would report directly to the President and advise him on scientific matters. Golden asked Truman to choose an eminent scientific leader, appoint that person as the President's science adviser, and select a Science Advisory Committee. When Truman later formed the Committee, over Lucius Clay's objections, the President established it within Wilson's ODM. By April 20, 1951, Oliver Buckley, the former president of Bell Telephone Labs, served as the Committee's Chairman and also as Truman's Science Advisor. The 10-member Committee included Bronk, Conant, DuBridge, James R. Killian, Jr. (who succeeded Karl Compton as president of the Massachusetts Institute of Technology [MIT] in 1948), Robert Oppenheimer, and Alan Waterman (chief scientist of the Office of Naval Research [ONR]). DuBridge succeeded Buckley as the Committee's Chairman on May 23, 1952.

The new National Science Board, convening again on January 3, 1951, drew up a ranked list of 10 candidates for the post of Director of the National Science Foundation (NSF) that included Detlev Bronk (listed 1st), Lloyd Berkner (3d), Alan Waterman (7th), and Everette DeGolyer (10th).[81] Biophysicist Bronk, who had served with the National Defense Research Committee (NDRC), the OSRD, and the ONR, was now president of Johns Hopkins and also president of the National Academy of Sciences (NAS), but he allegedly favored including the military in the NSF's purview. Conant took the list of candidates to the White House, but Golden did not favor any NSF involvement in "the military stuff,"[82] unlike Bronk, who said he would accept only if it did. Bronk withdrew his name from consideration at the NSB's meeting in February. When Berkner took another post, Conant joined Golden in passing down the list to recommend Waterman. On March 9, the NSB approved Truman's intention to nominate Waterman, who also was the personal

choice of DuBridge, Karl Compton (Waterman's former boss), Vannevar Bush (whom Truman had not appointed to the NSB), and other colleagues. The Senate confirmed Waterman later in the month; he took his oath of office on April 6 for a 6-year term, at $15,000 per year. The NSF began formal operations from its headquarters in the District of Columbia in a building at 16th and I Streets, N.W.,[83] and it was funded by an appropriation of $225,000 for fiscal year 1950–51. Physicist Paul E. Klopsteg left the Argonne National Laboratory to serve as Assistant Director of the Division of Mathematical, Physical, and Engineering Sciences, one of the NSF's four program divisions.

The debate about how to fight and end the conflict in Korea continued at home and abroad. Hoover, Taft, and other isolationists within and outside Congress responded to Truman's recent actions by beginning a public debate on the administration's policy in Europe and around the world. The Republicans, after decrying the stalemate in Korea and attacking the Truman administration as "soft" on Communism, gained seats in the mid-term elections on November 7 for the 82d Congress, but the Democrats retained margins of 35 in the House and 2 in the Senate.[84] Former President Herbert Hoover's radio address, on December 20, recommended against any further involvement in campaigns in Europe and also proposed ending aid to Europe until its countries provided for their own defense. Hoover, returning to the isolationism popular in the years between the world wars, called for building up American air and naval forces and the Nation's bases in the Pacific, while rearming Japan. On January 5, 1951, Taft began a major debate in a Senate speech that supported Hoover's views. Taft complained that Truman planned and conducted foreign policy without consulting the people or their elected representatives, thereby questioning the relative authority of the President and Congress in fulfilling U.S. obligations. On the same day, the Soviet Union agreed to resume joint deliberations with the United States to settle the former's debt of $11 billion for Lend-Lease aid received during World War II; talks begin on January 15, but they ended without agreement 16 days later. On January 6, Americans learned that the Truman administration continued to supply arms and ammunition to the Republic of China on Taiwan, despite the President's earlier claim that the United States would no longer do so; Acheson confirmed the shipments on April 25.

Kenneth Wherry, still the Senate's minority leader, continued the foreign-policy argument by introducing a resolution on January 8 prohibiting the dispatch to Europe of additional U.S. ground forces without Congress' approval. General Eisenhower, NATO's Supreme Allied Commander Europe (SACEUR) since December 1950, appeared before an informal joint session of Congress on February 1, 1951, and supported sending additional American personnel, equipment, and supplies to aid Europe's defense. Later that month, Secretary Marshall, while testifying during hearings of the Senate's Armed Services and Foreign Relations Committees, related his and the Joint Chiefs of Staff's existing plan to add four divisions to the American forces in Europe during 1951. Marshall and the service chiefs also thought unwise any attempt by Congress to limit the number of U.S. troops assigned to NATO. Thomas Dewey and fellow Republican Harold E. Stassen then supported the Truman administration's plans for European defense as an Eisenhower program. The Republican-led debate on foreign policy fizzled out on April 4, 2 days after Eisenhower took command at Paris, when the Senate approved the plan to add four U.S. divisions in Europe. The Senators asked the President to seek their approval for any further augmentation there and for sending other troops elsewhere in the world. Truman applauded the Senate's approval of his plans for collective security, but he ignored the Senators' request for prior consultation.

As the debate continued, the U.N. forces slowed and then halted the Communists' second invasion of South Korea, and Truman continued to act to bolster

national defense. The President, in a news conference on January 4, 1951, confirmed that he would not authorize using atomic bombs on the People's Republic of China unless Congress declared war. By January 15, U.N. forces retreated to a line about 50 miles south of Seoul in South Korea's narrow waist. There, the 8th Army, augmented by Canadian forces that had been arriving since December 19, regrouped under a new leader. On December 26, Lt. General Matthew B. Ridgway had replaced Lt. General Walker, who died when his jeep collided with a ROK truck on an icy road. Ridgway, who led the 82d Airborne Division and then the XVIII Airborne Corps in combat in Europe during World War II and served as one of the Army's Deputy Chiefs of Staff in the postwar years, took hold and raised the 8th Army's morale. The 8th Army attacked forces of the People's Republic of China[85] and North Korean People's Army (PRC–NKPA) 2 days later, pitting its advantages in armor, artillery, airpower, and logistics against the Communists' much larger edge in manpower. On March 14–15, 1951, U.N. forces retook Seoul and some areas north of the 38th parallel.

On December 28, 1950, as the 8th Army began its offensive, Truman signed a bill extending vocation rehabilitation and other benefits "to certain persons who served in the military, naval, or air service on or after June 27, 1950."[86] The new act, made more permanent in 1952, provided for veterans of Korea and elsewhere, with at least 90 days of service, benefits and educational opportunities similar to those granted to World War II veterans. On March 9, 1951, Secretary Marshall reported that U.S. armed forces now totaled 2.9 million men and women, a twofold increase since the Korean war began. The defense buildup, based on NSC–68/2, Marshall predicted, would be completed by mid-1952, well ahead of the original projection of fiscal year 1953–54. Truman signed a bill on June 19 that further amended the Selective Service Act of 1948 to "provide for the common defense and security of the United States and to permit the more effective utilization of [its] manpower resources * * * by authorizing universal military training."[87] The new law authorized the registration, classification, and examination of potential draftees to July 1, 1955; lowered the age of inductees to 18.5 years; increased their length of service from 1.5 to 2 years of active duty and added reserve participation that raised their total obligation to 8 years; and authorized increased personnel levels for the three services.

By now, the Korean war not only aroused concern about how the United States would meet its immediate defense needs there and worldwide but also imparted urgency to considerations of the long-term supply of mineral commodities and other strategic and critical raw materials. Truman, in his economic report to Congress on January 12, 1951, warned the Nation that while "the rapid expansion of the defense program must be the first objective in all that we do," the Korean conflict was not a global war. He called for "a continuing balance between the build-up of military strength and the build-up of economic strength," so that America would not be "weak at some future time if total military strength should then be required." Truman urged his fellow citizens to prevent the deteriorations of our agricultural, range, and forest lands and the misuse of "critically needed minerals and supplies of water," although "the use of some of these resources" must be expanded "to reach the full potential of our industrial strength."[88] "If Western Europe were to fall to Soviet Russia," he cautioned in the State of the Union Message 4 days earlier, "it would double the Soviet supply of coal and triple the Soviet supply of steel. If the free countries of Asia and Africa should fall to Soviet Russia, we would lose the sources of many of our most vital raw materials, including uranium, which is the basis of our atomic power."[89]

Truman, in his economic report, also estimated that more than $140 billion would be required in fiscal years 1950–51 and 1951–52 for national security programs, including U.S. forces, economic and military aid abroad, atomic energy, and

stockpiling. Production would be expanded under the DPA, but the President also asked that supplies of critical materials and products remaining after defense needs were met be divided equitably among other users. Truman also recommended wisely developing all resources, promoting conservation of scarce materials, and developing substitutes. The Truman administration's price ceilings, established to fight inflation, led to reducing American demands for materials imports and ended the wholesale importing of these resources that occurred during July–December 1950. Truman specifically urged increasing industry's steel capacity and its supplies of iron ore by drawing on lower grade domestic sources and those in Labrador, through the proposed St. Lawrence Seaway and Power Project, and Venezuela to offset losses from the declining Lake Superior deposits. Interior Secretary Chapman also noted the need to continually expand the domestic economy but highlighted the dangers of concentrating "solely on short-term goals"[90] and making unlimited demands on America's limited natural resources without making "proper provision for the use of resources from beyond our own shores."[91] America, Chapman continued, now imported "75 percent or more"[92] of the amounts consumed of nine strategic-mineral commodities—asbestos, chromite, cobalt, industrial diamonds, manganese, mica, nickel, platinum, and tin; it also imported more than 45 percent of the lead and zinc used and from 25 to 75 percent of bauxite, fluorspar, and tungsten. Chapman, as his recent predecessors did in times of crisis, called for more information about domestic and foreign sources of minerals, as well as the Nation's fuel, land, and water resources. Members of the new 82d Congress reintroduced bills to provide an accelerated program of topographic and geologic mapping and a comprehensive effort to acquire basic data in water resources.

On January 15, Truman announced a Federal budget for fiscal year 1951–52 that called for $71.6 billion in expenditures, 78 percent more than those for 1950–51, but anticipated only $55.1 billion in revenues, leaving a large expected deficit of $16.5 billion, which would be triple that of fiscal 1950–51. The President recommended increasing natural-resources appropriations to $2.5 billion, half of which would be devoted to atomic-energy programs because the "economic and military strength of this country is dependent upon the availability and wise use of our basic natural resources." "These resources," Truman noted, "while extensive, are not unlimited. Our land, forest, water, mineral, power, atomic, and other resources made a vital contribution toward winning World War II and are now called upon to support the present military expansion. The Federal Government," he added, "has a large responsibility for ensuring the use of these resources to maximum advantage."[93] "Our natural resources programs," the President continued, "are being modified in order to make the greatest immediate contribution to our national security. In some cases, it is necessary to postpone desirable long-range development in order to accomplish urgent immediate objectives."[94] Truman noted that "the resources programs of the various agencies emphasize the development of Alaska for economic security and national defense." He pointed out how USGS and USBM efforts during and since World War II "concentrated upon research on the adequacy of mineral resources, the discovery of new resources, and means for improved development, conservation, and use of existing reserves. All of these activities," he emphasized, "have a clear defense significance and budget increases are recommended to accelerate them."[95]

While Truman waited for congressional action on these and related measures, he established the President's Materials Policy Commission (PMPC) on January 19, as urged by Stuart Symington's National Security Resources Board (NSRB). Truman asked the new PMPC "to make an objective inquiry into all major aspects of the problem of assuring an adequate supply of production materials for our long-range needs and to make recommendations which will assist me in formulating a comprehensive policy on such materials." The President expected the PMPC to study the long-range outlook for requirements and supply and balance them. The

"prospect and estimated extent of shortages," the "consistency and adequacy of existing Government policies, plans, and programs," and those "of private industry practices" required considering "the needs and resources of the nations" cooperating closely with the United States "on military security and economic matters."[96] Truman appointed William S. Paley, president of the Columbia Broadcasting System, as the PMPC's Chairman. Paley's commissioners included George R. Brown, a construction engineer and executive at Brown and Root in Houston, Texas; Arthur H. Bunker, president of the Climax Molybdenum Company; Eric Hodgins, an editor and writer for *Fortune*; and Edward S. Mason, dean of Harvard's School of Public Administration and president of the American Economic Association. To assist the PMPC's deliberations, Philip H. Coombs directed its executive staff and oversaw its advisory staff of groups on domestic and foreign energy resources, technology, security and market policy, and commodity studies. USGS geologist Thomas Lovering served full time as the agency's liaison and one of the PMPC's four staff consultants. USGS geologists completed evaluations for the PMPC about marginal ore reserves of 15 mineral commodities and began studies of practices in exploration and discovery for several important minerals. Other contributors to the studies and reports included Alan Bateman; Everette DeGolyer; Samuel Lasky, on loan full time from his post as Staff Assistant for Minerals in the Interior Secretary's Office; the still-active Charles Leith; petroleum geologist A. Irving Levorsen, dean of Stanford's School of Mineral Sciences during 1946–50; Hugh McKinstry; and Eger Murphree.

On February 23, 1951, Michael Kirwan's House appropriations subcommittee began hearings on the USGS budget request of $22.9 million for fiscal year 1951–52, an increase of about $3.5 million from 1950–51. Director Wrather reemphasized his agency's continuing major responsibility for gathering "basic data about our natural resources" but stated that the increasing requirements for defense made necessary the "conversion of a full peacetime program into a twofold program for peace and defense * * * coordinated by the end of the current fiscal year." The USGS intended its long-range, topographic-mapping program "to obtain complete coverage of the continental United States with either [larger-scale] engineering or general-purpose maps,"[97] the latter about 70 percent less expensive to produce. The Army Engineers, Wrather continued, asked the USGS, on November 28, 1950, "to reorient and expand its mapping program so as to complete the mapping of about 600,000 square miles in the United States and Alaska by 1957." General-purpose maps would have to cover only 60 percent of Alaska; the provisional series of maps at 1:250,000 now being compiled from aeronautical charts would suffice for all of the Territory until a more accurate and same-scale series could be prepared from reconnaissance surveys. An additional 25,000 square miles also must be mapped, he cautioned, to meet additional "known civil requirements directly related to national defense"[98] to support the war economy. The USGS planned to enlarge its mapping force as rapidly as possible and prudent by asking for an increase of $1.65 million in SIR funds for topographic surveys and mapping. Wrather also expected to receive for USGS topographic work $1.8 million in cooperative funds from States, counties, and municipalities and $2.9 million in transfers from other Federal agencies; of the latter sum, $2.3 million would come from the USBR, and the Department of Defense (DoD) would contribute only $300,000 in USAF monies. He reminded the subcommittee how difficult it was for the USGS to maintain a technical staff to meet requests from other agencies when the funds required for doing so were not in the agency's own appropriations.

Wrather also stressed how USGS geologic and mineral-resource surveys and mapping, and its water-resource investigations, also would serve national defense and the mobilization economy, but he did not add that the service would be at the expense, as in both world wars, of drawing on the agency's basic-research capital

built up before and after those conflicts. "Much of the current [geologic] program based on the urgent peacetime need and search for essential minerals needed only minor modification in emphasis or timing," he noted, as the effort already emphasized mineral and fuel commodities "now critically short of defense needs," including those required for jet engines. The peacetime economy placed demands upon the Nation's water supplies "well above the peak consumption of World War II"[99] and now increased even further by industrial mobilization and military use. Requests for information about the availability and adequacy of water supplies were increasing as they had in the past conflicts.

The USGS asked for SIR-funds increases for fiscal year 1951–52 of $1.7 million for its geologic work and $700,000 for water-related investigations, including some 40 new streamgaging stations at military establishments. Wrather expected cooperative and transfer funds to add $3.3 million and $5.6 million, respectively, to these sums, of which the DoD would supply $1,590,000. The USGS also requested $86,000 more for its land-classification and mineral-lease supervision and regulation activities, which Wrather assured the subcommittee continued to "contribute directly to the requirements of the Nation's mineral program"[100] by aiding increased reserves and production. As the Public Buildings Administration insisted that $1.8 million was needed to complete the multiyear relocation of USGS facilities to the Denver Federal Center, Wrather asked for half that sum to continue the work. Benton Jensen, ever frugal but very interested in this work in his State, now placed on record the $150,000 program of soil and moisture conservation proposed by the USGS but disallowed, unwisely said Jensen, by the Budget Bureau. William Norrell asked to record another statement extolling Wrather's abilities, "so the general public may know the caliber of the official that we have at the head of the Geological Survey."[101] Jensen thought it "fair to say that you have the most able and efficient agency in Government today."[102] Representative Kirwan, not to be outdone in what was becoming a bipartisan lovefest, added he believed the hearing seemed "like attending the best university in the country to sit here and listen to you."[103] Without dissent, the subcommittee approved the full amount of the estimate for the USGS.

By the time Interior's appropriations bill came up for review by the full House in late April 1951, the Korean war entered a new phase. After a stalemate of several months near the 38th parallel, General MacArthur, convinced that Chinese troops and airfields on the Manchurian border must be attacked in order to win the war, threatened the People's Republic of China with bombing and naval bombardment, even though the administration continued to try to avoid a wider war. MacArthur denounced Truman's intent to begin peace talks in a letter to Joseph Martin, Jr. (R–MA), now the House minority leader. Five days later, on March 24, MacArthur summoned the Chinese in Korea to surrender or face attacks against their homeland. Martin released MacArthur's letter for publication, although both men knew the U.S. Constitution barred America's military from making national policy or opposing the Commander in Chief, including his order in December that all military missives to the press be preapproved by the administration. After Truman consulted General Bradley and the Joint Chiefs of Staff, he fired MacArthur for insubordination. On April 11, Truman relieved MacArthur of his four commands—U.N. forces, Allied Powers in the Far East, U.S. Forces in the Far East, and U.S. Army Forces in the Far East—and replaced him with Lt. General Ridgway. General James A. Van Fleet took over the 8th Army. From many citizens in the United States, including prominent Members of Congress, came roars of outrage and calls for impeaching the President and the Secretary of Defense. The firestorm far exceeded the one generated when Eisenhower fired Patton for insubordination in 1945. MacArthur, while addressing an informal joint session of Congress on April 19, defended his policy preferences but accepted Truman's decision. MacArthur, recalling an old barrack-room ballad, said at the end of his military career that,

like all old soldiers, he would just vanish in the mists of time.[104] MacArthur did not go quietly; he testified before Senate committee hearings during May 3–June 25 and continued to harbor Presidential aspirations. Truman ignored political and public pressure to reinstate MacArthur. Ridgway, gaining a fourth star, continued to use the U.N. forces' superior firepower and planned to save lives by avoiding costly attacks intended to gain showy tactical victories but only nonstrategic territory.

When the USGS appropriation request reached the House floor, only a few days after MacArthur addressed Congress, Representative James C. Davis (D–GA) insisted on cutting the appropriations of all the civilian Federal agencies. The USGS budget, Davis emphasized, not only remained uncut but was also some 24 percent greater than the previous year. Davis offered an amendment to slash USGS appropriations by $1 million, half from topography and the remainder divided equally between geology and water resources. Both Kirwan and Jensen opposed this change. Although Jensen reminded his colleagues that he had supported all budget reductions so far proposed, he insisted that he could not vote to cut USGS funds. The agency remained vital to the Nation's defense, Jensen continued, and he also felt that Wrather, whom he praised again, would not ask for any more money than he needed. Jensen rallied some of his colleagues to try to prevent the adoption of Davis' amendment, but it passed by a majority of just two votes.

By the time the Senate appropriations subcommittee took up Interior's funding bill on May 8, the tension had been somewhat relieved. Congress evaluated MacArthur's dismissal and the American public, losing interest in the process and its results, admitted that perhaps there was something to Truman's side of the story. Secretary Chapman, appearing before Carl Hayden's subcommittee, deplored the House's reduction of $39 million in his Department's request. He specifically asked to restore the USGS cuts because "the money is being spent for the gathering of scientific data which is essential to our economic development and our security."[105] When Wrather testified 3 days later, he also emphasized that all USGS programs continued to trail "far behind national needs."

> **Each time the Nation faces an emergency this lag becomes apparent, and determined efforts are made to fill the need quickly. In this emergency period, I feel that I should stress the effects of this cut on the defense effort.[106]**

Wrather then responded to several specific and difficult questions. Although the Nation faced critical shortages of about 50 mineral commodities, Wrather told the Senators, the DMA did not plan to transfer funds to the USGS after the third quarter of fiscal year 1950–51. Senator Joseph C. O'Mahoney (D–WY), who also chaired the Committee on Interior and Insular Affairs, repeated his earlier view that "mapping is essential from every point of view in the development of our minerals in the country."[107] "Every other civilized country in world is adequately mapped,"[108] Hayden obligingly noted and asked yet again how long it would take the USGS to map the United States. FitzGerald estimated "Nearly 50 years at the present rate."[109] Wrather clarified the magnitude of the problem by adding that if the USGS put off civilian mapping requirements during the current emergency, the agency could not meet military needs, even though its work remained well coordinated with the U.S. Coast and Geodetic Survey (USCGS) and other mapping agencies. The USGS did expect to receive from the Army Map Service (AMS) $200,000, only one-fifth of the required sum, to begin aerial photography before trees leafed out in critical areas in 1952, provided the item remained in the fourth military supplement bill. Wrather and Carl Paulsen convinced Senator Guy Cordon (R–OR), who lauded USGS topographic-mapping achievements, that all aspects of the agency's water-resources investigations aided national defense. Wrather, in pointing out the paucity of adequate records that were at least 50 years old and therefore vitally required for

present planning and utilization of water, emphasized the need for "a continuous record over longer periods of time and * * * a more thorough network of stream gauging" for determinations of adequacy, "especially within the smaller areas."[110] Hayden's subcommittee, still mostly sympathetic to USGS needs but under instructions from the full Senate to cut all estimates for personal services by at least 10 percent, trimmed another $600,000 from the USGS budget. Senator Paul H. Douglas (D–IL) proposed a further reduction of $2 million, but the Senate voted for the funding level recommended by its subcommittee. The House accepted the Senate's figure.

When Truman signed Interior's appropriations bill on August 31, 1951, the new law, plus supplemental funding of $150,000, enacted on November 1, and nearly $714,000 more on June 5, 1952, gave the USGS almost $22,164,000 for fiscal year 1951–52. The directly appropriated funds of about $21,864,000 later reported by the USGS rose by $3.4 million, or nearly 19 percent, above the past year's sum. Those monies represented 46 percent of the total of slightly more than $48 million received by the agency. The act of August 31, 1951, limited USGS personal services to $13,455,000 and made $3.3 million "available only for cooperation with States or municipalities for water resources investigations."[111] Federal transfer funds reached $20.8 million, or 43 percent of the total monies, including $8.3 million from the DoD, $6.2 million from the AEC, and $3.9 million from the USBR. States, counties, and municipalities provided nearly $5.3 million, an increase of about $773,000 over 1950–51. These outside funds of almost $26.1 million represented nearly 55 percent of the USGS total and an increase of more than 46 percent from the previous year's sum. To meet the growing needs during the national emergency, the USGS continued to increase its staff, and the agency received nearly $948,000 for general administration during 1951–52. On June 30, 1951, the USGS employed 6,917 persons, of whom 5,477 were classified as full time, 297 as part time (or when actually employed [WAE]), and 1,143 as field assistants and laborers. Of this total, 414 people worked in the Director's Office, including the 122 in Fred Graff's Branch of Map Reproduction. The staffs of the four program divisions rose by 10 to 33 percent in the 8 months during November 1950–June 1951.

The transfers of money from other agencies, as always, were two sided and drew internal comment. On May 2, 1952, the Pick and Hammer Club's players, in their annual show, "Future Indefinite or Down to Our Last Centennial,"[112] looked back in "1978" from offices in Washington and "Various field stations in the wilds of Fairfax"[113] in Virginia. Some of the songsters recalled, to the tune of the "Surrey with the Fringe on Top" from "Oklahoma!," that nothing had changed since they decided the USGS was "Unhinged on Top":

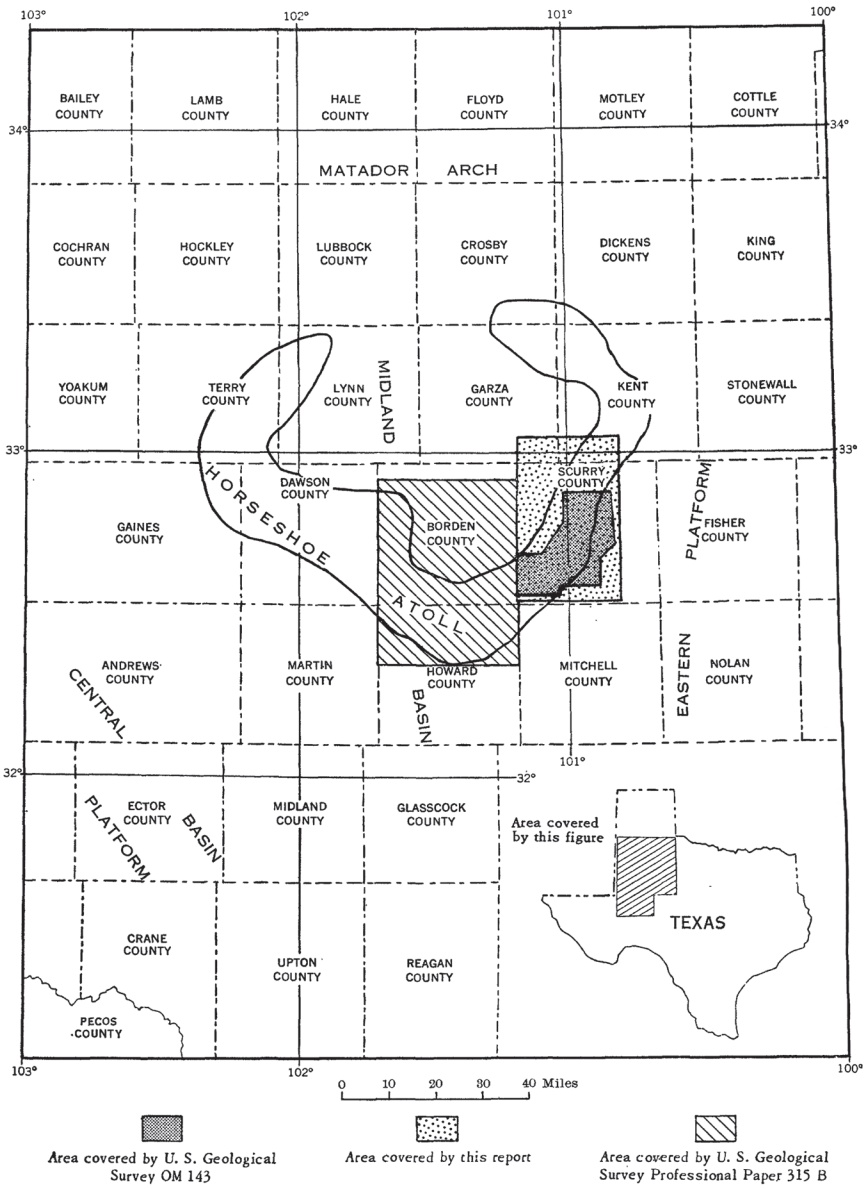
If you like your life topsy-turvy,
Why not come and work for the Survey?
Come and try to work for the Survey
With the brass on top.
No research and no time for science;
All our days belong to our clients;
Question[n]aires must have full compliance,
And they never stop.
The Director's purple and the C.G.'s pale,
The Branch Chiefs are all in a lather;
While field men chained to their desks, go stale
Answering memos from Wrather.
D.M.A. demands our attention,
Nothing else is worthy of mention,
Other work is held in suspension,
Or is just let drop.
Oh, it's scurvy in the Survey with the brass on the top.[114]

The Geologic Division received $14,801,000 during fiscal year 1951–52, including $5,763,000 in direct appropriations, or 39 percent of its total funds, for its salaries and operations by its 1,593 employees as of June 30, 1951. The staff of 1,306 full-time and 183 part-time employees and 104 field assistants and laborers represented a significant increase since November 3, 1950. About $8,825,000 of the total funds came from other Federal agencies. These monies included $5,799,000 transferred by the AEC, which almost doubled its 1950–51 transfer; $1,478,000 from the DoD; $994,000 from the Army and its Engineers; $698,000, from Interior; $376,000 from the USBR; and $241,000 from the Mutual Security Agency. States, counties, and municipalities added another $212,000, an increase of about $7,000.

In fiscal year 1951–52, Geologic Division scientists evaluated applications for grants and loans received by the DMEA and also evaluated measures for the preparation and enforcement of contracts, both forwarded to the Division by the DMEA. Howard Rothrock and his team completed their 1:48,000 map (OM–143) and preliminary evaluation of the geology of the Scurry Reef and other parts of the Horseshoe Atoll in the Midland Basin for the PAD. After Rothrock resigned in March 1952, to return to work in the oil industry, Richard E. Bergenback, Donald Myers, Philip T. Stafford, and Robert Terriere extended the detailed reef studies, focusing on the size, shape, porosity, and arrangement of the reef's stratigraphic reservoirs to assist planning for continued development, and completed assessing the regional geology of adjacent parts of northwest Texas. Members of the Division also prepared confidential reports on the world's resources of chromium and tungsten for the NSRB, now under Jack C. Gorrie, after Truman asked Stuart Symington to lead the Reconstruction Finance Corporation; enlarged the already extensive program of geologic mapping and drilling for the AEC; expanded military geology and associated studies for the Army Engineers and other parts of the DoD; and increased geological work abroad for the DoS. Expanding the Geologic Division's facilities and personnel to meet "the acute demands of national defense," as twice before during the century, Wrather noted, drew heavily on the organization's existing resources and slowed its regular work. The Director asked for the means to enable the USGS "to continue its traditional and carefully planned research and geologic mapping from which have come byproducts that have proved valuable in times of crisis."[115]

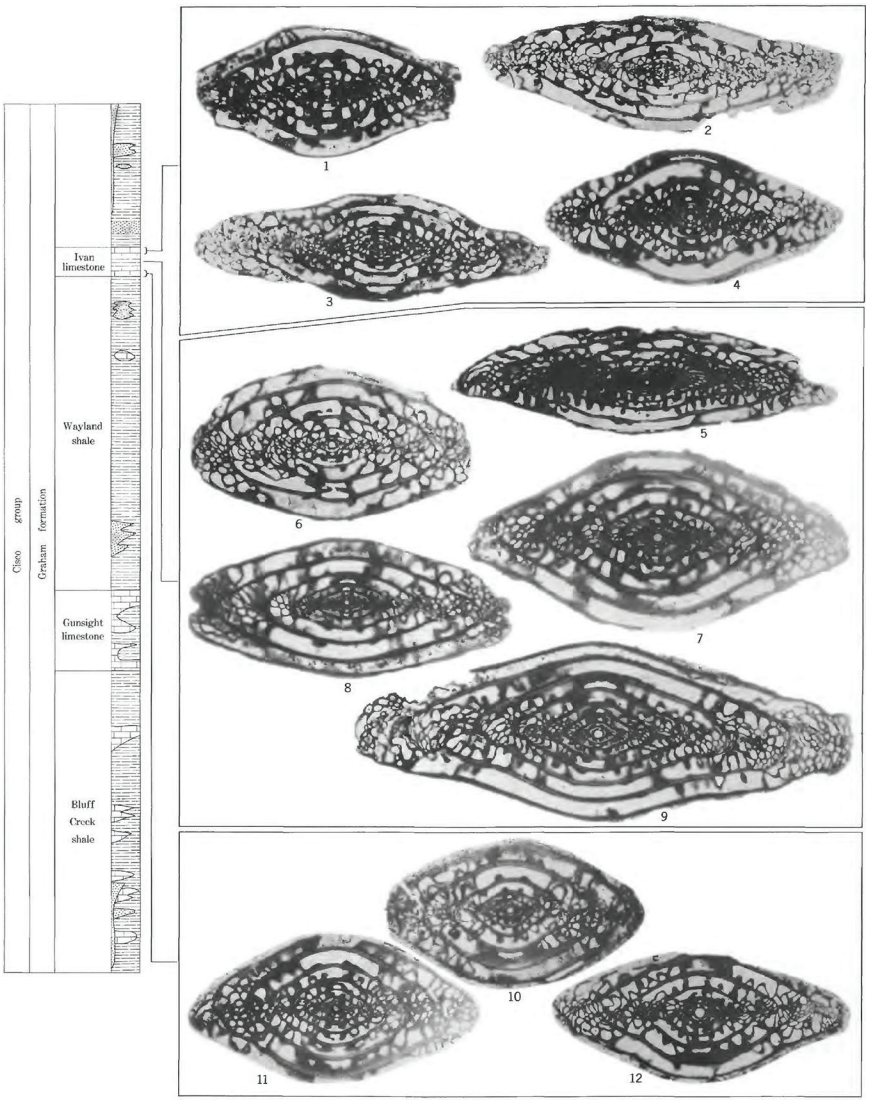
During 1951–52, a USGS geologist joined the scientists who formally advised the National Science Foundation, which received $3.5 million for its salaries and operations during the fiscal year. William Rubey was the only geologist on the 11-member committee advising Paul Klopsteg's Division of Mathematical, Physical, and Engineering Sciences. Three of that Division's initial grants that year went to earth scientists. Truman's letter of January 15, 1952, printed in the NSF's initial Annual Report, noted that the Foundation "will support these areas of basic research and science training where the needs are most acute and will ultimately assume the major responsibility for the Federal Government's support of basic research through grant or contract."[116] James Conant, writing in the same volume, suggested this investment should distinguish carefully between applied research, which he likened to "drilling for oil when you know where the oil is," and fundamental research, which he termed "prospecting for oil in a hitherto unexplored area." To clarify the distinction, Conant recommended substituting "programmatic" for applied and "uncommitted"[117] for fundamental research.

While Rubey advised the NSF's Division[118] during fiscal year 1951–52, members of the Mineral Deposits Branch began or continued field investigations in 66 projects in 28 States and Puerto Rico, including exploratory drilling in Iowa, Utah, and Wisconsin. Branch geochemists developed field tests for antimony, barium, manganese, and selenium to add to their array of determination techniques. Branch geologists conducted regional studies of mineral resources in New England and



This map (originally at 1 inch = 30 miles) outlines the area enclosed by the upper Paleozoic Horseshoe Atoll, an arcuate structure some 70–90 miles across in the northern Midland Basin of west Texas. Wells in the area began producing oil in 1948. Recovery from the Scurry Reef and the atoll's other fields reached 140 million barrels by the end of 1952. Howard Rothrock led a USGS team's investigation during most of 1950–53 into the atoll's biotas, rocks, structure, and petroleum occurrences; the team was aided by colleagues from the Petroleum Administration for Defense, the U.S. Bureau of Mines, and the Texas Bureau of Economic Geology. Most of the oil occurred in Pennsylvanian-age limestone reservoirs, capped by Permian shales, along the structure's crest. (From Stafford, 1959, fig. 1.)

adjacent parts of New York and in the Arkansas, Red, and White River Basins. Structural delineation of favorable areas for lead-zinc deposits in Wisconsin helped to disclose a new ore body, expected to yield 100 million tons with an estimated value of $135 million. USGS geologists and paleontologists aided the Tennessee Division of Geology's discovery of a major zinc ore body. Analyses of bauxite samples from Arkansas indicated that they contained about one pound of columbium (niobium), a vital component of jet engines and steel, per ton of ore. The amount of columbium handled during the State's current production of bauxite nearly equaled the present global production of the metal. Branch geologists and geochemists examined the possibility of using waste materials from bauxite and titanium metal plants as new sources of columbium. During the year, the mineral industry also made several important discoveries using USGS recommendations based on its mineral investigations aided by the new geochemical and geophysical tools and methods. In the West, Branch geologists discovered two potentially valuable phosphate deposits in Idaho and Montana. Geochemical prospecting by Branch members led to new extensions by the mining industry of the main cobalt-copper veins in Idaho's Blackbird district. A producer of mercury in California



These transverse sections show specimens of species of the fusulinids *Dunbarinella* (fig. 5) and *Triticites* (figs. 1–4, 6–12) from the Ivan Limestone Member of the Graham Formation (Pennsylvanian); the specimens are from Brown and Coleman Counties of central Texas southeast of the upper Paleozoic Horseshoe Atoll. These microfossils were collected from outcrops and well cores during 1949–55 and identified, dated, and correlated by Donald Myers and other USGS geologists and paleontologists. Fusulinids (extinct protozoan foraminifers) had calcareous multichambered endoskeletons known as "tests." Fusulinids occurred in marine sedimentary strata deposited during Ordovician through Triassic time. (From Myers, 1960, pl. 21; all figures originally shown at × 10.)

revealed the existence of four large ore bodies, whose discovery depended in part on USGS-developed ideas of structural control of the district's deposits.

Vincent McKelvey succeeded Hubert Keiser as Chief of the Trace Elements Planning and Coordination Office. Lorin Stieff and Thomas Stern expanded their laboratory studies of the isotopic geochemistry of uranium and thorium and their decay products. In an attempt to bring order to and guide the renewed uranium boom in the West,[119] the AEC and the USGS revised their popular booklet "Prospecting for Uranium," including sections on the uranium-bearing minerals, with color photographs of samples of autunite, carnotite, pitchblende, tobernite, and uranophane ores; where to look and how to test for them; tests for fluorescence and radioactivity; prospecting with Geiger counters; laboratory assays and selling procedures; and applicable laws and regulations.[120] The Colorado Plateau Project continued to expand its staff and geographic coverage by mapping deposit-bearing formations outside the Uravan Mineral Belt in key areas in Arizona, New Mexico, and Utah to understand regional trends and controls on mineral distribution. The results, as before, aided exploration for economically important occurrences and their testing by diamond drilling and subsequent resource appraisal. To aid uranium prospectors in Alaska, TEPCO reopened its testing laboratory at College in facilities provided by the University of Alaska.

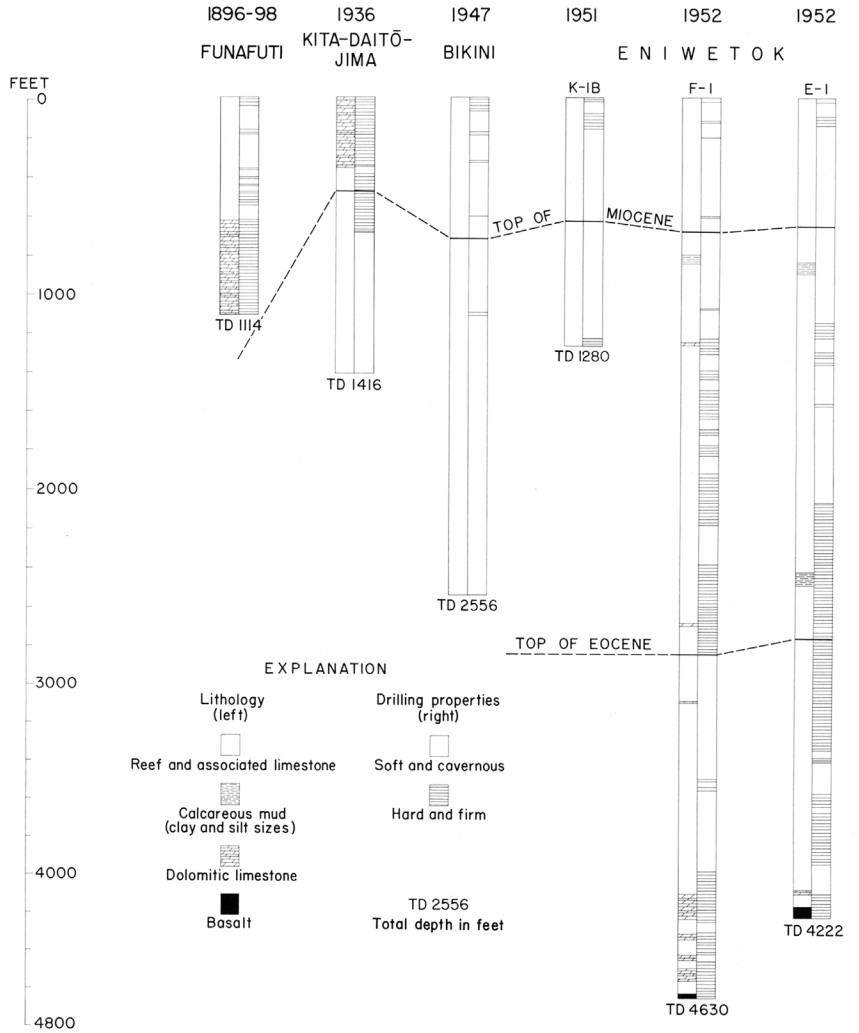
During fiscal year 1951–52, the Fuels Branch continued its twin emphases on petroleum and coal. Branch projects included 27 regional studies, in 18 actual or potential petroleum-bearing States, all of which were carefully integrated with operations by the oil and gas industry, the State geological surveys, and other agencies. Fuels geologists published a total of 20 Oil and Gas Investigations Maps and Charts, Circulars, and Professional Papers on regional topics in seven States in the West, issued a revised map of U.S. oil and gas fields, and also widened their investigations of the oil-shale deposits in the Green River Formation in Colorado and Utah. Division biostratigraphers began studies of the zonation and correlation of oil-producing strata in the Williston Basin of North Dakota and Montana. As part of the continuing systematic reappraisal of the Nation's coal resources, Paul Averitt's group finished new assessments of the overall coal resources of Colorado, Indiana, North Dakota, South Dakota, and Virginia. Other specialists continued detailed geologic mapping of coal fields in 11 States—Colorado, Indiana, Kentucky, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Washington, and Wyoming—and published reports on the coals of South Dakota and Virginia. James Schopf's studies of coal samples at the Coal Geology Laboratory in Ohio yielded new information about the paleobotany, petrography, and radioactivity of coals that helped to solve problems in dating and correlating coal beds, increasing the understanding of their genesis, and advising how to use them as effective sources of synthetic liquid fuels and chemicals.

In the General Geology Branch, scientists continued or began work on 19 projects in 15 States, Puerto Rico, Hawaii, and the Aleutians during fiscal year 1951–52. In September 1951, Clifford Kaye completed his geologic mapping of the San Juan metropolitan area, published in 1959 at 1:30,000, and Isla Mona in the Windward Passage and his studies of Puerto Rico's Quaternary shorelines begun in March 1949. All eruptive activity ceased at Parícutin on March 4, 1952, but Carl Fries, Jr., Celedonio Gutiérrez, and their colleagues, with the continued support of the USGS, the U.S. State Department, the Instituto Nacional para la Investigación de Recursos Minerales, and other government organizations in Mexico continued to study the volcano through June 1953. In the Aleutians, during the 1951 and 1952 field seasons, George D. Fraser, Willis H. Nelson, Howard Powers, and Ray Wilcox led several field teams of 12 other USGS geologists working from facilities on, and supported by, the USGS schooner *Eider*, in mapping and studying additional islands. The teams completed work on Kiska and Amchitka. They also examined three of the smaller islands in the Rat group, four of the nine Delarofs, and southern Adak, Kagalaska, Kanaga, and Tanaga in the western Andreanof Islands and published coverage at 1:25,000 for the smaller islands and from 1:63,360 to 1:250,000 for the larger islands or groups of islands.

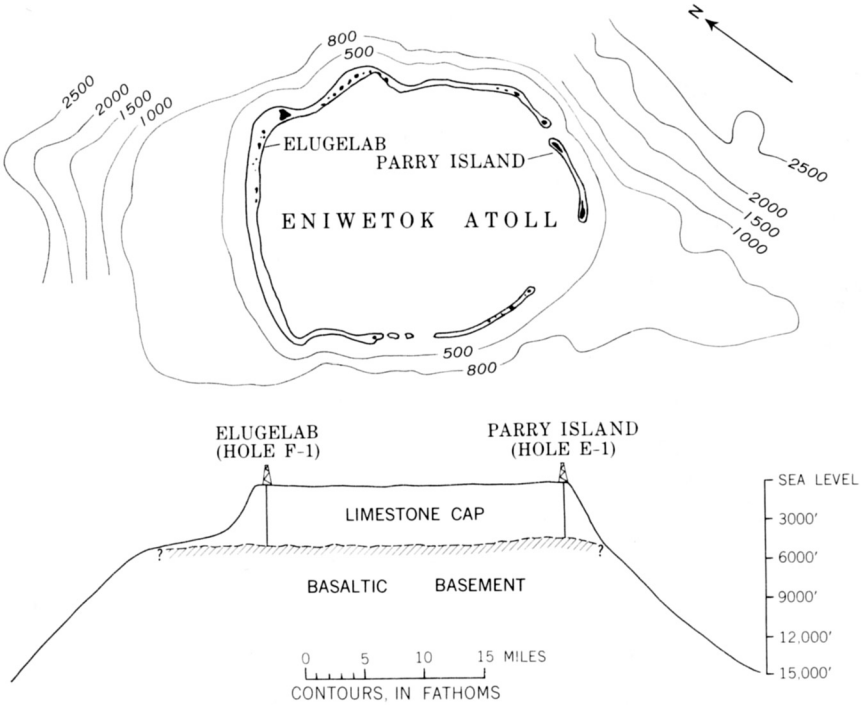
The Engineering Geology Branch conducted 17 field projects in 10 States during fiscal year 1951–52. About a third of the Branch's program remained centered on the Missouri River Basin, to support Interior's development effort there, and included studies of landslides at South Dakota's Fort Randall Reservoir. Branch geologists mapped detailed areas along the upper Green River in Utah to furnish data for a new regional project of land development and waterpower. The Branch added four new cities—Denver, Los Angeles, Omaha, and Seattle—to its urban-mapping project[121] while continuing work in Great Falls in Montana, Knoxville in Tennessee, Portland in Oregon, and San Francisco in California; it also continued cooperative geologic mapping with Massachusetts and Rhode Island. Late in the fiscal year, Ray Wilcox, now the Branch's resident expert on volcanoes, traveled to Nicaragua to study, with Frank Simon, the results of the eruption in Santiago Crater. Wilcox advised Nicaragua's Government about ways and means to protect more effectively its people, agriculture, and livestock from future eruptions. The ONR and the Army Engineers supported geothermal investigations in arctic and subarctic locales by Branch scientists, some in cooperation with John Cederstrom,

David Hopkins, and other members of the Alaskan Geology, General Geology, Geophysics, and Military Geology Branches of the Geologic Division and the Ground Water Branch of the Water Resources Division. The investigators provided scientific and engineering information on the thickness and temperatures of permafrost, the effects of heated buildings on the cold reserve beneath them, and the time required for drill holes to reach thermal equilibrium.

Preparations for nuclear-weapons testing by the United States continued to involve USGS geologists in deep drilling and related studies in 1951–52. On January 25, 1951, aboveground tests of nuclear weapons began at the Nevada Proving Grounds (now the Nevada Test Site), an area chosen by the AEC in December 1950 that included Frenchman and Yucca Flats. The Mid-Pacific Expedition, a multiship effort during 1950–52 sponsored by the University of California and the Navy Electronics Laboratory (NEL) and led by Roger Revelle (Scripps Institution of Oceanography [SIO]) and Robert S. Dietz (NEL), included dredging on seamounts and related work at Bikini Atoll. Russell W. Raitt, Jr., extended the magnetic and seismic studies of 1946–47 with seismic-refraction surveys across and outward from Bikini and also over adjacent Sylvania Guyot to add to new data from coeval photography and bottom sampling of Cretaceous fossils. Raitt's results indicated a volcanic-rock basement below the lagoon at depths of about 2,000 to 6,900 feet. As part of preparations for additional nuclear-weapons tests, Harry Ladd directed drilling operations at Enewetak Atoll and initially used the same rotary core rig that



This diagram correlates the core-based stratigraphic records of deep wells drilled to depths of 1,114–4,630 feet on six island sites in the open (west-central) Pacific Ocean during 1896–1952. In addition to holes drilled on Funafuti, Kitadaito-jima (formerly North Borodino Island), and Bikini, they included the three deep holes drilled by Harry Ladd's USGS-industry team on separate islands in the Marshall Islands' Eniwetok (now Enewetak) Atoll during 1951–52, as part of scientific preparations for tests of the new U.S. thermonuclear weapon. In 1951, the team used the rotary core rig, the same one used on Bikini, but now truck mounted, to drill hole K–1B on Engebi Island, near the atoll's southeast end. K–1B descended to a depth of 1,280 feet (earlier reported as 1,285 feet), where it ended in Miocene sediments. In 1952, the team used a larger and taller trailer-mounted rig to drill hole E–1 on Parry (Medren) Island to a depth of 4,222 feet; coring recovered olivine basalt from the hole's lowest 14 feet. Hole F–1, to the northwest on Elugelab Island, reached a depth of 4,630 feet and basalt before the hole collapsed. (From Ladd and Schlanger, 1960, fig. 287; see also Ladd and others, 1953.)



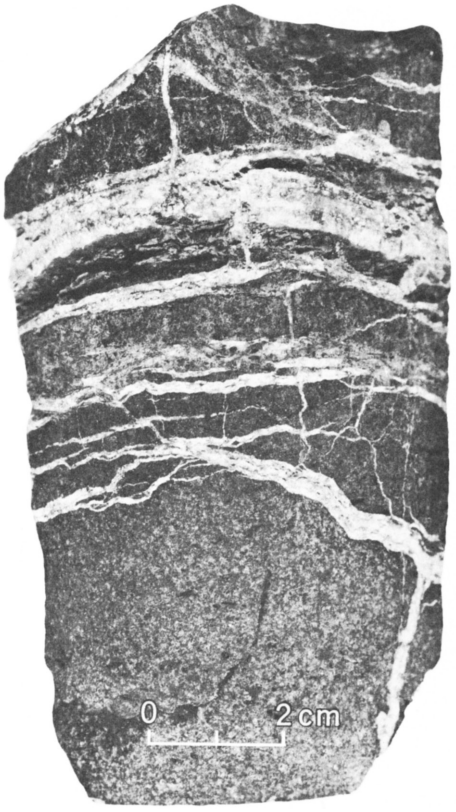
This generalized chart of Enewetak Atoll (above, originally at about 1 inch = 21 miles) and geologic section through Elugelab and Parry Islands (below), based on data from drill holes E–1 and F–1, "firmly established the fact that the foundation of that atoll is a basaltic volcano that rises 2 miles above the floor of the ocean." That conclusion confirmed the Darwin-Dana model, as coral-reef growth had kept pace with the rate at which the oceanic volcanic mountain sank. The study left undetermined the mechanism responsible for the sinking and the geologic age of the basement rocks. Contours on the chart show water depths in fathoms; 1 fathom = 6 feet. (Quotation, chart, and geologic section from Ladd and Schlanger, 1960, p. 899 and fig. 285.)

he had used on Bikini in 1947. The Armed Forces Special Weapons Project, the ONR, and the Navy provided planning and logistical support for the drilling for the AEC and the Los Alamos Scientific Laboratory. Ladd's team drilled four shallow holes on the seaward reef off Engebi before the tests in May 1950. Deeper wells at Enewetak followed in 1951–52, as part of the geological, geochemical, geophysical, and botanical workup. In 1951, Ladd's team drilled well K–1B on Engebi Island to a depth of 1,285 feet (later revised to 1,280 feet) before it tailed out in Miocene sediments. Two new wells, supervised and studied by Ladd, Earl Ingerson, and their USGS, ONR, and Los Alamos colleagues in 1952, passed through deepwater foraminiferal limestones of Eocene age, later also dated by radiometric methods. Members of the drilling team added "Basalt or Bust" to the wall of the geologists' office, and these wells finally reached basement rock. Well F–1 on Elugelab reached a depth of 4,630 feet before the hole collapsed. Joel Swartz took downhole thermal measurements as E–1 on Parry descended to 4,222 feet, where coring recovered 14 feet of fractured olivine basalt.[122] Ladd, who earlier favored Alexander Agassiz's reef theory, promptly put up on the rig a sign saying "Darwin Was Right!" In 1954, Kenneth Emery, Joshua Tracey, and Ladd acknowledged that the

> **[a]ccumulation of the shallow-water organisms seems to have been essentially continuous throughout most of the atoll's history, indicating a continuing or periodic submergence[123]**

in post-Cretaceous time. The cause and rate of basement-rock subsidence in these atolls remained to be determined.

Richard Rhodes, in his book "Dark Sun," recounted how work by Edward Teller, Ernest Lawrence, and other physicists led to the successful hydrogen bomb.[124] On November 1, 1952, 3 days before the Presidential election, the United States exploded at Enewetak the 10.4-megaton "Ivy Mike" thermonuclear device powered by the fusion of the hydrogen isotopes deuterium and tritium, the latter an artificially generated isotope whose half-life of 12.5 years also made it valuable



This specimen of olivine basalt from hole E–1 drilled in 1952 on Parry Island in Enewetak Atoll was part of the initial core, at 4,208–4,211 feet, of three cores recovered from the basement rock. Laboratory analyses showed that this basalt contained labradorite feldspar (60 percent), augite clinopyroxene (20 percent), olivine (15 percent), and opaque minerals (5 percent). Some of the lighter colored calcite veinlets that cross the basalt specimen contained greenish alteration products. Reaching basement rock on Parry confirmed the Darwin-Dana subsidence model of coral-reef formation; the corals grew upward at a rate that kept pace with the subsidence of the basement-rock foundation. Scale in centimeters (cm). (From Ladd and Schlanger, 1960, fig. 282; originally published in Ladd and others, 1953, pl. 1, fig. 1.)

as a tracer. The blast, whose explosive power exceeded by some thousand times that of the Hiroshima bomb, obliterated Elugelab and Engebi Islands. Eight months earlier, on February 26, Churchill announced that Britain had joined the atomic club after the British detonated a 25-kiloton device in the Montebello Islands, 50 miles off the northwest coast of Australia.

Federal support for development and science in Alaska led to the completion in 1951 of airports at Dillingham, Fort Yukon, Kotzebue, Ninilchik, and Seldovia and the transfer that September of the annual Alaska Science Conference (begun in Washington in November 1950) to the headquarters of Mount McKinley (now Denali) National Park. Wrather enacted Bradley's recommendation to consolidate Geologic Division activities in Alaska under unified management. Wrather's Survey order of March 10, 1952, established an Alaskan Geology Branch,[125] with George Gates as Chief, who operated from his office in San Francisco, and Ernest H. Lathram as Staff Geologist in Washington. The Alaskan Geology Branch assumed the functions and responsibilities of Gates' Alaskan Unit of the Alaskan and Foreign Geology Branch and the General Geology Branch's Aleutian Volcano Investigations Unit. The Geologic Division transferred personnel, records, and equipment of the former Alaskan Unit to San Francisco. Wrather asked Gates' Alaskan Geology Branch, in collaboration with the Division's other Branches and John Reed (Sr.), still the Director's Staff Coordinator for Foreign and Territorial Functions, to plan "a comprehensive program of geologic investigations for Alaska combining short-term economic and military objectives and long-range systematic geologic mapping and research designed to meet the broadest foreseeable national and Territorial needs."[126] Among the new Branch's geologists working in Alaska, Arthur Grantz, who joined the USGS in 1949, studied magnetite deposits near Tuxedni Bay and newly hired C. Ladell ("Pete") Sainsbury investigated antimony occurrences at the south tip of the Cleveland Peninsula and tungsten deposits in the Hyder district, both north of Ketchikan. Coal investigations continued in the Bering River, Kenai, Matanuska, and Nenana fields. Late in the fiscal year, the USGS issued a preliminary report on the Katalla oil field. USGS scientists also observed river-ice conditions near highway and railroad bridges, operated portable core drills, and studied tracked-vehicle trafficability in the Territory.

Specific planning for fieldwork in Alaska's NPR–4 during the 1952 season began with a meeting at Fairbanks, during March 11–13, of the members of the renamed Executive Operating Committee. The attendees agreed to continue or begin test wells at Grandstand, Gubik, Square Lake, Umiat, Weasel Creek, and Wolf Creek. They proposed six similar drilling operations, including new wells at East Titaluk, West Big Bend, and West Meade, for 1953, and four or more wells, including a pre-Cretaceous test down to 9,000 to 12,000 feet in 1954. A subcommittee summarized work to date in the five principal areas of NPR–4, the coastal plain west and east of the Colville River, the northern foothills west and east of the Anaktuvuk River, and the southern foothills. As the program's goals were essentially met only on the coastal plain west of the Colville, achieving its objectives in the other four areas would require "a full-scale exploration program with emphasis on drilling * * * at least through 1957."[127] The new Advisory Committee, chaired by Captain Meade, met during April 14–15 in Denver, where Wrather, John Reed (Sr.), George Gryc, and William Fischer represented the USGS. In June, a Navy survey board, composed of Navy officers and petroleum-industry civilians, evaluated the NPR concept and operations. The board, noting the difficulty and vulnerability of transport in NPR–4, suggested that it, as the least desirable of the existing reservations,

> **be transferred to another Government agency for administration at such time as feasible after the completion of the present exploratory program**

but that the NPR–4 program should be continued "at its present level in order not to lose current extensive investment," even though the work should "be considered only as an exploration of natural resources and not as a reserve."[128]

George Gryc's Navy Oil Unit operated three field groups in NPR–4 during June–August 1952. Samuel Keller's Party 1 examined the Canning-Shaviovik and Kemik Creek areas, including the Kemik anticline, and demonstrated minimum closures of 500 to 900 feet. Robert Detterman's Party 2 looked at the northern foothills area between the Chandler and Anaktuvuk Rivers, one that included the Big Bend, Grandstand, and Hawk anticlines and discovered closures of 200 to 1,000 feet. Later efforts in Washington proved that the area's photogeologic maps were accurate only where the geology was uncomplicated and good vertical control existed. William Brosgé's USGS-funded Party 3, including Dutro, Mangus, and Reiser, mapped some 5,000 square miles in the northeastern Brooks Range between the Sagavanirktok and Kongakut Rivers, almost as far east as the Canadian boundary. Only four wells were drilled during 1952 "to conserve fuel for the drilling of 2 deep tests planned for 1953."[129]

Members of the Military Geology Branch continued studies in both hemispheres in 1951–52 but emphasized locales and topics in the Pacific and East Asia. A series of Executive orders between September 7, 1949, and June 29, 1951, transferred the administration of Guam, American Samoa, and the Trust Territory of the Pacific Islands (TTPI) from the Secretary of the Navy to the Secretary of the Interior,[130] as the initial step toward self-government. In Secretarial orders, Chapman assumed responsibility for American Samoa and the TTPI, each governed by a High Commissioner; former Senator Elbert Thomas continued to serve as the TTPI's civilian High Commissioner. In the MGB's Pacific Geologic Mapping Program, Joshua Tracey's team, including newly hired Seymour O. Schlanger, gained additional support from the USAF and began in August a 3-year survey of the botany, climate, geology, hydrology, marine geology, and soils of Guam, a U.S. unincorporated territory since 1950. Special reports completed by the MGB's Tokyo office for the Army's Chief Engineer in Japan included an inventory of aggregates on Okinawa. Among reports finished for the Office of the Chief of Engineers (OCE) in Washington were summaries of the state of ground, trafficability, airfield construction, and airborne operations in the combat zone between the 37th and 39th parallels in Korea (by Esther J. Aberdeen and Franklin Newhall) and water supplies and installations in Japan and South Korea (by Frederick Blach). In work about Europe, Nicholas Shreders completed for the OCE geologic maps of Spain and Portugal at 1:250,000 on 82 sheets and 1:1,000,000 on 35 sheets. Spain's Francisco Franco and Portugal's António Salazar agreed on April 15, 1952, to increase their mutual military collaboration and its relation to NATO's plans for defending Europe. The MGB's Edward C.T. Chao, Jack Rachlin, and four other geologists combined their efforts to produce annotated bibliographies and summaries of the adequacy of construction materials and water supplies in Belgium, France, Italy, Northern Ireland, Portugal, and Spain.

Wrather's Survey order of March 10, 1952, also renamed the Alaskan and Foreign Geology Branch as the Foreign Geology Branch but kept William Johnston as its Chief.[131] Geologic activities abroad increased in scope and tempo under the impetus of 1951's Mutual Security Act.[132] Branch members continued the long-range programs of metallic-minerals investigations in Brazil, Mexico, and Peru; resumed studies of nickel deposits in Cuba; and began reconnaissances in Chile and Paraguay as preparation for providing advice to their governments about mineral exploration programs. Cleaves Rogers and three Mexican colleagues finished a 3-year investigation of the Concepción de Oro in Zacateca. Benjamin N. Webber spent 1951–52 assessing mineral resources in British Guiana (Guyana). Philip Guild completed his 4-year study of the geology and mineral resources in Brazil's Congonhas district. Herbert Hawkes, Jr., supported by the MSA and the (British

Colonial) Geological Survey of Nigeria, examined the Nyeba lead-zinc district. Data from USGS studies in India led to determining 6 million tons of proved reserves of manganese. Fuels investigations in Thailand aided the discovery of 10 million tons of coal in deposits previously thought insignificant. In the Philippines, work by Earl Irving and Ronald Sorem led to a report on the archipelago's sedimentary basins that generated renewed interest in domestic exploration for oil[133] and to mapping potential manganese deposits in the central islands. Branch geologists also helped to train 27 foreign geologists in field areas in the United States and to give others 3-month orientations in administration, science, and technology in and outside Washington.

The Geophysics Branch's airborne geophysical surveys, in 12 Northeastern and Western States, returned data for 40,000 miles of traverses during 1951–52, aided by recent hires. Geophysicist Randolph W. ("Bill") Bromery, a pilot who served with the Tuskegee Airmen, joined the Branch's airborne-surveys unit in 1948. Bromery continued to encounter racial prejudice in many of his contacts with the world outside the agency, as did his colleague Roland G. Henderson, a geodetic engineer and geophysicist. As Bromery later recalled, Balsley and William J. Dempsey (Sr.) oversaw the design and construction of the Curvilinear Graph Rectifier "to draw the magnetic profiles to fit the actual horizontal map scales and the changes in the vertical scale of the magnetic gamma readings." In 1951, Henderson gained a third job classification as a mathematician, as did his colleague Isidore Zietz; together they developed "the mathematical techniques for the geological interpretations of the airborne magnetic data."[134] One of the airborne survey's flights over California's Sacramento Valley mapped the largest intensity aeromagnetic anomaly, 1,200 gammas at 10,000 feet, yet recorded in the United States. Other flights over the Duluth gabbro and its copper-nickel ores in Minnesota and Wisconsin also recorded high-intensity anomalies. Total-intensity aeromagnetic maps of counties and quadrangles principally in Indiana, but also in Maine, Michigan, Minnesota, Missouri, and New Mexico, continued being prepared and published, at 1:63,360, with contour intervals of 10 to 100 gammas, by Dempsey and his colleagues. The Branch issued a primer about aeromagnetic maps to aid user interpretation. The now-routine airborne surveys for radioactivity proved increasingly useful in uranium investigations and were extended to new areas in Arizona, Florida, Minnesota, and Utah. Dempsey organized a compilation unit to digitize, plot, and analyze the strip-chart records from the airborne scintillometers. Ground surveys, in 11 States, Alaska, and two areas outside North America, continued to return data useful for determining bedrock depths, finding and studying aquifers and buried-valley systems, and aiding mineral-deposits investigations.

Chief Topographic Engineer (CTE) Gerald FitzGerald continued to fine-tune the Topographic Division during fiscal year 1951–52. On November 5, 1951, FitzGerald appointed photogrammetrist George S. Druhot, editor of the *Topographic Division Bulletin*, to replace Alfred Stiefel as Chief of the Coordination and Liaison Section, in Robert Lyddan's Plans and Coordination Branch. Wrather and FitzGerald also changed the boundaries of the Division's four geographic regions to distribute its workload more evenly and to expedite the mapping of high-priority areas for the Defense Department. As realigned by a Survey order[135] on December 27, the Atlantic Region now contained Puerto Rico and all of the States east of the Mississippi River, except for Alabama, Florida, Michigan, and Mississippi. That quartet passed to the Central Region, which extended west from the Mississippi to the western boundaries of North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma. The Rocky Mountain Region included Alaska Territory, Colorado, Montana, New Mexico, Texas, and Wyoming. The Pacific Region comprised the remaining seven Western States and Hawaii Territory.

On June 30, 1951, the Topographic Division employed 2,566 persons, 859 more than on November 3, 1950; 1,997 were full time, 18 were part time, and 551 were field assistants and laborers. The Division received $18,485,000 to support surveys and mapping by its staff during fiscal year 1951–52, about $5.3 million more than the previous year's total. Direct appropriations provided $8,386,000, or about 45 percent of all the funds received by the Division. The Army and its Engineers, spurred by the national emergency,[136] transferred to the Division $4,772,000, more than $4 million above the amount in 1950–51 and double the largest sum given by the War Department during any year in World War II. The Air Force transferred $811,000 to the Division, an increase of $187,000. These gains returned the Division's staff and programs to heavy dependence on sustained funding by the military. The USBR, by providing $2.2 million, continued to lead the cooperating Federal agencies, but that figure represented a loss of $591,000 from 1950–51's contribution and required a one-third reduction of the Division's operations in the Missouri River Basin. Other Federal agencies shifted an additional $480,000. Twenty-nine States (four more than in 1950–51) plus counties and municipalities transferred some $1,783,000, a gain of more than $534,000.

The Topographic Division directed its program during fiscal year 1951–52 largely toward meeting the immediate needs of the Defense Department, an effort only in its second of six projected years ending by the beginning of fiscal 1957–58. When the DoD set earlier completion dates for mapping certain areas, the Division diverted persons from projects begun in other areas, hired additional personnel, and awarded contracts to cover separate mapping operations. The three regional offices at Arlington, Rolla, and Sacramento were quartered in new air-conditioned buildings designed to meet the requirements of mapping operations, and additional air-conditioned space was provided at Denver. To raise production capacity, the Division increased double-shift operations in all its photomapping units and overtime work in nearly all its offices. Contract mapping, of areas comprising 16,000 square miles at a cost of $1.5 million, and representing a continued departure from usual practice, forced the Division experts to write detailed specifications for the work to be performed and establish procedures for inspecting and testing the work so that it would comply with well-established internal standards. The Trimetrogon Section prepared 400 special charts, depicting 376,000 square miles, 60 percent of which were newly compiled, for the USAF under its increased funding. The Section also did some special mapping for other Federal agencies, including a test of a new slotted-template method on maps at 1:24,000 of 55 quadrangles in Louisiana. The Division limited its mapping for Federal agencies not directly involved with national defense; the Budget Bureau's procedures set the priorities for these efforts, even though the work could not begin until the Division increased its capacity. In 1951–52, Division employees completed 69,500 square miles of topographic mapping in the conterminous United States and began mapping Puerto Rico at 1:30,000. USGS base and contour editions in Spanish of 1:200,000 and 1:240,000 topographic maps of Puerto Rico and adjacent islands appeared, respectively, in 1951 and 1952. In Alaska,[137] field parties, supported by seven helicopters, mapped areas totaling about 16,400 square miles at 1:63,360 and nearly 37,000 square miles at 1:250,000. The Division continued to publish and distribute its civilian edition of the AMS's 1:250,000 national series but, on July 23, 1951, responsibility for the Transportation Maps of the United States being compiled for the Bureau of Public Roads passed from the Division to the USCGS. The Division, supported by the State Department's Technical Cooperation Administration and the Mutual Security Agency, also continued to train topographic engineers and photogrammetrists from free-world nations and provided advice on, specifications for, and supervision, inspection, and testing of air-photo and map compilation.

Topographic Division experts also continued to try to improve mapping equipment and methods during fiscal year 1951–52. Research to adapt electronic

methods[138] to establish more efficient geodetic control received considerable attention. Tests of mapping for which elevations were based upon vertical measurements by an aircraft equipped with radar, shoran, and a sensitive barometric altimeter proved encouraging. The polastrodial continued to make possible the daylight observations of azimuth under conditions previously considered unfavorable. Division members assessed optical-reading telescopic alidades and a new, pendulum-type, self-leveling, and optical-reading alidade, expecting both the optical-reading and auto-leveling features to speed field mapping. In photogrammetry, the Division and the USAF worked to develop an improved Twinplex stereoplotting instrument. The Division let contracts for additional Multiplex equipment, and Kelsh and universal plotters, whose acquisition was expected to increase capacity by nearly 40 percent, and signed other contracts to produce 10 of the new and improved T–11 aerial cameras with Planigon lenses nearly free of distortion.

The Water Resources Division managed about $12,441,000 for salaries and operations during fiscal year 1951–52 by its staff of 2,111 persons, a gain of 604 since November 3, 1950; 1,550 employees were full time, 92 were part time, and 469 were field assistants and laborers. Of the total funds, nearly $5,847,000, or about 47 percent, came from direct appropriations, of which $3,300,000 was limited to cooperation with the States, counties, and municipalities. These governments supplied slightly more than $3,285,000, representing a gain of $219,000. The USBR's transfer fell to $1,269,000, a loss of $200,000, although the Division still operated in the Missouri River Basin 290 streamgaging stations and assessed groundwater quantity and quality at more than 100 locations. The DoD transferred $979,000, and the DoS shifted about $131,000. The AEC raised its support to more than $192,000, and other Federal agencies supplied about $649,000.

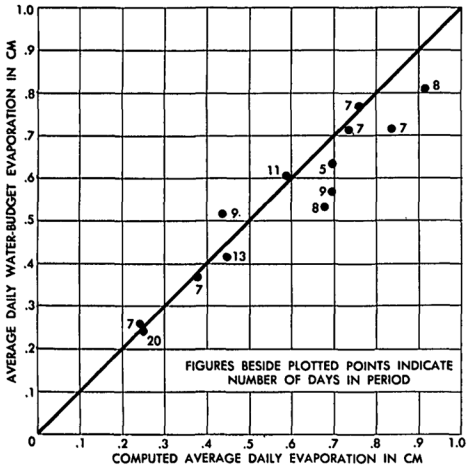
The Division, among its organizational changes during the year, activated in November 1951 a Program Control Branch, with George Ferguson as its Chief, to develop and operate a coordinated system of defining, planning, budgeting, allocating, and accounting for all of the Division's programs. Ferguson's new Branch contained Carl W. Morgan's Fiscal Management Section, Kenneth B. Young's Program Development Section, and George D'A. De Buchanne's Program Coordination Section, with John C. Kammerer as the Branch's staff scientist. In 1952, the Technical Coordination Branch added a third Section, Water Utilization (the Branch's former title to 1948), led by Jack B. Graham, to its existing Sections of Research and Technical Reports. The new Section's projects included Rivers and Land Morphology, Soil and Moisture, Water Losses, and Water Utilization. The Division's activities abroad expanded significantly in 1952, and some of its members trained hydrologists from Brazil, Canada, India, Mexico, and other countries. Other Division personnel began or continued observations of surface water and groundwater in Guam, Samoa, and the U.S. Virgin Islands.

The Surface Water Branch during fiscal year 1951–52 continued to observe streamflow at about 6,400 stations and, as before, publish the results in the annual series of Water-Supply Papers. The Branch established in 1952 two new units—Tate Dalrymple's Technical Standards Section and Carl E. Kindsvater's Research Section. Branch members experimented with using electronic machines to compute stream-discharge records, installed continuous water-temperature recorders at some gaging stations to provide data for ready consultation by industry, and prepared a preliminary report on the return flow of irrigation water in the Columbia River Basin. Studies of sediment movement in streams furnished data for Federal and State agencies involved in planning and operating storage reservoirs, diversion works, and canal systems.

As part of Interior's program to protect the public lands in the West under the Department's care and maintain their high productivity, Branch members continued their studies of soil and moisture conservation, aided by the USGS appropriation

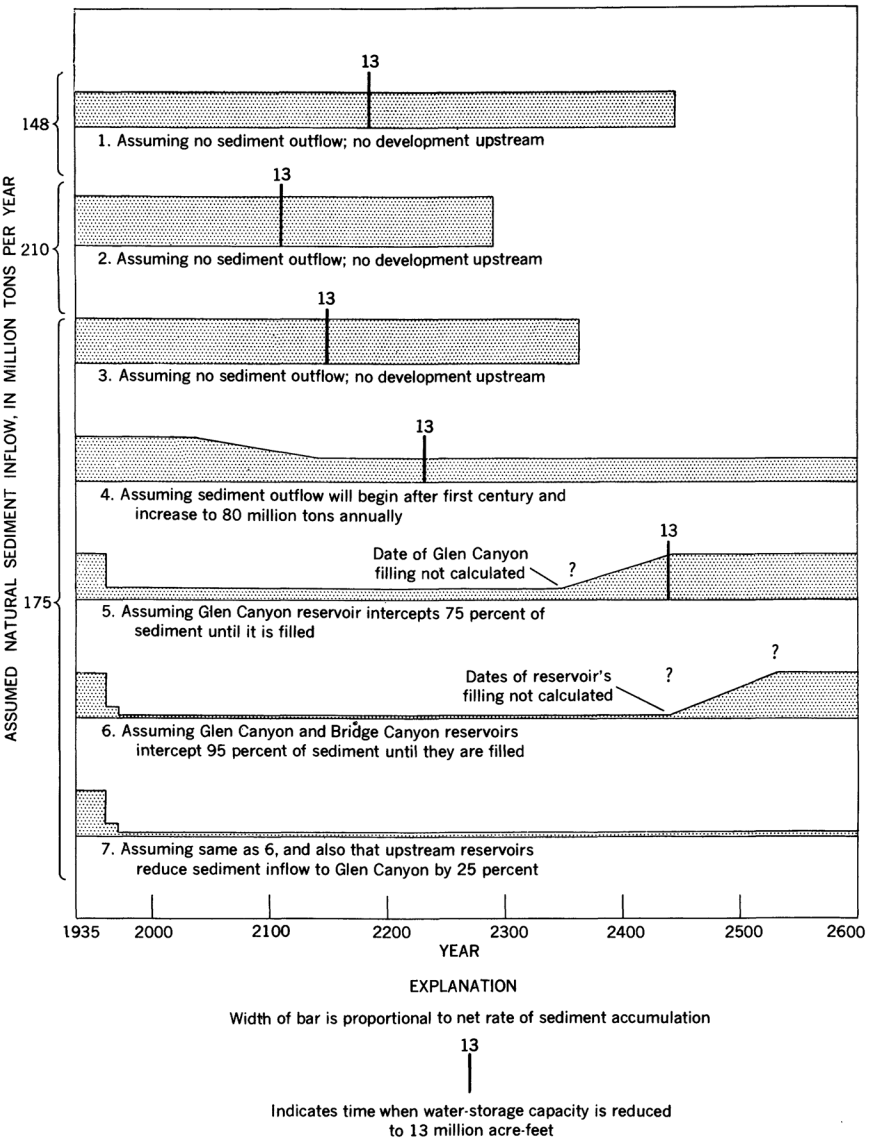
now increased to $43,700. As new sources of water were discovered, and additional arid and semiarid land was put to better use, the Surface Water Branch, in collaboration with other Interior agencies, examined and reported on critical soil-erosion problems and evaluated conservation methods. For many reservoirs, Branch personnel determined the rate of sediment fill and amount of upstream erosion and continued studies of sediment origin, stream-channel entry, transport, and deposition, including problems of scour and fill. In cooperation with and funded by the USBR, the Branch expanded its investigation of the amount of sediment carried as bedload, rather than suspended load, at several sites in the Missouri River Basin, but the reduction in transfer funds curtailed basinwide investigations. Branch members also essentially completed the study at Lake Hefner to develop basic methods for more accurately measuring evaporation from reservoirs. Cooperative work with the USBR, the NEL, and the Weather Bureau determined the amounts and rates of losses by evaporation from reservoirs and applied them to evaluating Lake Mead to help manage the waters of the lower Colorado River. Branch experts also investigated using reflected sound waves to determine the thickness and character of bottom sediments at several locations and the nature of the foundation at the site of a potential major engineering structure in Maine.

In 1952, the Ground Water Branch also began two new Sections—Ground Water Hydraulics, led by William F. Guyton and then Russell H. Brown when the Division shifted Guyton to studies of national water use, and Manpower and Training, directed by Garald G. ("Jerry") Parker (Sr.). Branch members, experimenting with new equipment and methods, began a study of numerical methods and electronic computers to measure areal groundwater recharge, flow, and discharge. This investigation grew from work at Indiana's Eagle Lake on the effects of proposed drainage ditches on lake and water-table levels and groundwater recharge. Efforts by Branch personnel at El Paso, Texas, showed that wells there might be used to artificially charge aquifers. Deep drilling in Utah revealed aquifers that might be discharging into Utah Lake water that could be recovered without affecting the overlying aquifers now being used. Branch members continued using electric logs to determine not only the mineral content of groundwater but the approximate concentrations of different ions in the waters of various aquifers. A new technique introduced measured amounts of water into wells to gain quantitative data on their value as indicators of water level and aquifer productivity. Branch specialists developed an electrically operated water-stage recorder for wells too small or deep for standard floats that made the continuous collection of water-level data less costly. They also converted 8-day recording gages to 30-day operations by using an inexpensive battery-operated clock escapement. Investigations at and near the Army arsenal at Huntsville in Alabama indicated that the structure of limestone strata controlled groundwater occurrences in a manner not previously observed, suggesting that similar supplies might be found and evaluated in limestones of other areas. The Branch planned studies of the effect of groundwater movement on the accumulation of oil and gas that an industry geologist suggested might lead to new discoveries of petroleum in presently unproductive areas. Routine investigations also aided the choice of a site near Portsmouth, Ohio, for a new atomic-energy plant. In 1952, the Division began gathering preliminary data on a few representative samples of the natural, or "background," radioactivity of water resources, with the principal hopes of finding new sources of fissionable materials, gathering information vital to public health in the event that radioactive materials accidentally or deliberately entered water bodies, and advancing hydrological understanding. Mining hydrology studies in eastern Tennessee solved the problem of water inflow that prevented extraction of zinc from an important deposit and led to investigations of similar problems in Arkansas, Michigan, and Minnesota and proposals for work on others in Alabama and Wisconsin.



This figure compares computed and observed daily evaporation in centimeters as determined by the Cummings Radiation Integrator at Lake Hefner, near Oklahoma City, during 1950–52. Interagency atmospheric and water sensors were deployed on or below barges anchored in and floating evaporation pans in shoreline frames at Lake Hefner and later at southern Nevada's Lake Mead (1952–53). USGS personnel and collaborating specialists from the Navy Bureau of Ships, the Navy Electronics Laboratory (NEL), the U.S. Bureau of Reclamation (USBR), and the Weather Bureau gathered data to test the energy-budget and mass-transfer methods of estimating thermal-energy budgets at Lakes Hefner and Mead. They determined that Lake Mead lost by evaporation during 1952–53 about 875,000 acre-feet, an amount equivalent to 7 feet of water lakewide. (From Harbeck, 1952, fig. 92; see also Harbeck and others, 1958.)

These actuarial projections for sediment fill in the reservoir behind Hoover Dam during the years 2000 to 2600 are based on the results of atmospheric, geodetic, hydrographic, hydrologic, and sedimentation surveys of southern Nevada's Lake Mead in 1947–49. To improve estimates of water-reservoir capacity and loss, and to propose remedial treatments, specialists from the U.S. Bureau of Reclamation (USBR), the U.S. Coast and Geodetic Survey (USCGS), the Navy, the USGS, and the Weather Bureau joined in studying evaporation and sedimentation rates in Lake Mead and also in Lake Hefner in central Oklahoma. (From Smith, W.O., and others, 1960, fig. 64; modified from Thomas, 1954, fig. 9.)



As part of the Ground Water Branch's work abroad, Thomas E. Eakin conducted a field reconnaissance during November 1951–January 1952 of Iran's water resources and recommended long-term technical assistance in investigating that country's ground and surface waters. Eakin then served as the Water Resources Division's representative on the USGS Foreign Activities Committee. The Branch sent Joseph W. Lang to Tehran to advise the Shah's government about developing its groundwater resources; during April–October 1952, Lang investigated 25 areas throughout Iran, including several locales along the Caspian Sea's southern shore. Other members of the Branch began studies of 2,000 irrigation wells in India's Ganges Plain, started new investigations in Libya, and built a discharge integrator for Chile.

In response to continued concern about nationwide problems of water pollution and its abatement, the Quality of Water Branch exchanged data during fiscal year 1951–52 on streamflow and the chemical and physical properties of surface water and groundwater with public agencies that collected information primarily on bacteriological pollution; the cooperatively published interpretations of the combined information included a pollution survey of Ohio's part of Lake Erie.

Branch members contributed physical and chemical data from irrigation projects to those who tried to control the increasing concentrations of mineral contaminants formed by reusing water. Branch researchers also determined the minimum flows necessary to flush harmful pollution from industrial plants and sewage so that managers could make usable the waters of certain reaches of dam-controlled streams. These data also supported groundwater studies that included the contamination of certain aquifers by leaks from poorly cased wells, the effects of mixing groundwaters of varied chemical qualities, pollutant dispersal from surface disposal of wastes, and the encroachment of oil-field brines and oceanic waters into freshwater aquifers. Investigations of disposals of septic-tank effluent near Paducah, Kentucky, demonstrated that effluent might be drained safely into permeable but unsaturated rock units if the nature of the rocks had been confirmed by hydraulic research. The Branch began collecting data on the minimum requirements of many industrial users and, in places, the necessity of conserving the supply by wise reuse, by obtaining preliminary information on the water needs of the aluminum, carbon black, copper, paper and pulp, petroleum, and rayon industries.

In the Conservation Division during fiscal year 1951–52, Harold Duncan appointed to his staff two Assistants—Robert Spratt (shifted from his similar post in John Northrop's Mineral Classification Branch) and Johnson B. Mitchell. The Division received almost $1,332,000, or $132,000 more than the amount in the previous year, for classifying lands and supervising mining and oil and gas leases. Of that total, about $1,284,000 came from direct appropriations to continue the Division's limited dependence on outside funding. The Navy transferred to the Division nearly $31,000, and States, counties, and municipalities resumed their contributions with some $12,000, but the USBR and other Federal agencies shifted only $4,600. As of June 30, 1951, the Division employed 233 persons, or 24 more than on November 3, 1950; 210 were full time, 4 were part time, and 19 were field assistants and laborers.

Increased demands led the Conservation Division's Mineral Classification Branch to markedly accelerate its services during fiscal year 1951–52. Division members handled more than 28,000 cases, a 65-percent increase over those processed in 1950–51, due to the clearance of applications for radioactive and other mineral rights under the leasing laws applicable to the public lands. The Mining Branch supervised nearly 1,200 properties that yielded royalties of slightly less than $3.8 million. The production of coal fell by more than 800,000 tons, owing to greater competition from other fuels and the prolonged strike in the steelworks that produced a general slowdown in other industries. The production of sodium rose, as did that of lead and zinc, although that pair's lower grade ore somewhat offset the increased tonnage. Potassium production remained about the same as in 1950–51, but one of the new producers in New Mexico began operations in December 1951 and another expected to begin work in October 1952. The Oil and Gas Leasing Branch supervised more than 63,160 oil and gas properties on the public lands, an increase of 62 percent from those managed in 1950–51; some 1,360 properties were on acquired lands, and nearly 7,740 leaseholds were on Indian lands. Royalties from fuels produced from public, acquired, and Indian lands rose to more than $44.2 million (an increase of $9.4 million), production from NPR–2's 262 active wells yielded royalties of nearly $817,000, and the Army's Rio Vista gas field supplied an additional $416,000. The Water and Power Branch supervised construction and operations on 940 power projects—nearly 135 under license from the Federal Power Commission, more than 600 under the Interior's permit or grant, and 200 in cooperation with the BIA. Members of the Branch performing classification work increased power-site reserves in 23 States and Alaska to nearly 7 million acres. They also investigated the geology of 6 dam sites, completed topographic surveys

of sites for 8 dams and 1 reservoir, plus 41 miles of river channels, and published maps of 7 dam sites and 89 miles of river channels.

In the fall of 1951, while truce talks in Korea that began during the summer remained stalemated, the United States extended its mutual-defense arrangements, and World War II officially ended. When Winston Churchill returned as Britain's Prime Minister, Frederick Lindemann (Lord Cherwell) again replaced Henry Tizard as the Government's chief scientific adviser. Although Zhou Enlai rejected in January a U.N. offer for a cease-fire in Korea, Yakov Malik made a similar proposal in the Security Council on June 23. Negotiations started at Kaesong on July 10 and continued on October 25 at Panmunjom, where Vice Admiral Turner Joy led the U.N. Command's delegation. The participants principally discussed establishing cease-fire and demarcation lines, prisoner exchanges, and airfield reconstruction, proposing as supervisors of any agreement representatives from Czechoslovakia, Poland, Sweden, and Switzerland. Meanwhile, the United States and the Republic of the Philippines strengthened their ties by implementing on August 30 a mutual free-trade pact that extended to 1954 and promised gradual reductions in tariffs for an interval of 20 years thereafter as a supplement to the rehabilitation and military assistance acts of 1946. On September 1, 1951, the United States completed the ANZUS mutual-security and assistance treaties with Australia and New Zealand and also with the Philippines. Three days later, representatives of the United States and 48 other nations[139] met at San Francisco to sign a treaty of peace with Japan. The agreement, signed on September 8, gave Japan full sovereignty and independence, provided for withdrawing occupying forces within 90 days after ratification, eschewed reparations, and allowed the formation of a self-defense force. Japan recognized Korea's independence, surrendered all claims to Formosa (Taiwan), the Pescadores, the Kuril Islands,[140] Sakhalin, and the Pacific islands mandated to the Japanese by the League of Nations after World War I, and accepted U.N. trusteeship over the Ryukyu and Bonin Islands under the sole administration of the United States. In a separate treaty signed that day, Japan agreed to continue hosting U.S. armed forces and supply nonmilitary aid to the U.N.'s effort in Korea. On October 25, the Conservatives won Britain's national election and gained a 16-seat majority in the House of Commons. Two days later, Winston Churchill began a second term as Prime Minister and Minister of Defense. Anthony Eden rejoined Churchill for a second tour as his Foreign Secretary and presented the Colombo Plan to provide an initial £8 billion to aid economic development in Borneo, Ceylon, India, Pakistan, and Sarawak. In Noumeá on November 7, the ANZUS nations agreed to extend their pact's coverage to include Guam and the Trust Territory of the Pacific Islands. The U.S. Senate ratified the peace treaty with Japan and the mutual-defense pacts with Australia, Japan, New Zealand, and the Philippines on March 20, 1952. World War II in the Pacific officially ended on April 28, as the American-Japanese pact for mutual security went into effect; the Japanese began diplomatic relations with Taiwan on August 5, and the United States loaned some 70 frigates and landing craft to Japan on November 12.

Early in January 1952 and again early in April, Churchill, Eden, and Lindemann came to Washington to review with Truman, the Secretaries of Defense, State, and the Treasury, and Harriman their joint concerns in foreign policy, especially the recent activities designed to secure Europe's defense. As part of their mutual agreements, the two countries announced on January 18 a short-term minerals exchange by purchase that provided Britain with 1 million long tons of U.S. steel, scrap, and pig iron in return for 20 long tons of tin and 55 million pounds of aluminum; the United States promised to replace the aluminum by its own exports by mid-1953. The Truman administration agreed on May 5 to station U.S. troops, by Iceland's request on April 7, 1951, at Icelandic facilities as part of NATO and completed on April 27 a similar agreement with Denmark for the defense of

Greenland during the next 20 years. Nine days earlier, France, West Germany, Italy, and the three Benelux nations signed a treaty to integrate their coal and steel markets, and the West Germans later joined the pact. On September 6, Portugal and the United States agreed to have the Azores included in NATO's defense plan. NATO's Council, while meeting in Ottawa during September 15–20, decided to invite Greece and Turkey to join the pact, which they did in February 1952; ground forces from both countries continued to serve with the U.N. Command in Korea. On September 20, representatives of Britain, France, and the United States met in Washington to try to end the legal occupation of West Germany and to add the Federal Republic's armed forces to a European army but on a fair-share basis. George Marshall resigned as Secretary of Defense on the following day. To succeed Marshall as Secretary, Truman nominated Robert Lovett, formerly Stimson's Assistant Secretary of War for Air during 1941–45 and Marshall's Under Secretary of State in 1947–49.

As another step in postwar rehabilitation and defense of Europe, Truman declared that the state of war between the United States and Germany ended officially on October 24, 1951. The United States and Yugoslavia signed an agreement on November 14 by which the former, beginning in July 1952, promised to supply Marshal Tito's country with artillery, jet aircraft, tanks, and other military equipment, materials, and services. That decision reflected Tito's opposition to the People's Republic of China's participation in the Korean conflict and his government's improved relations with Italy and West Germany. In January 1952, the United States and the Soviet Union offered differing plans in the United Nations to control atomic energy by continuing inspections and prohibitions, but neither country accepted the other's plan. During the second Truman-Churchill meeting, the United States announced on April 6 that it was developing a hydrogen bomb. On April 9, the two leaders issued an agreement in which the United States promised not to store nuclear weapons at its air bases in Britain without British approval. Eisenhower, who had said in January that he would respond to a Presidential draft, announced his resignation as SACEUR on April 12; a month later, Ridgway replaced Eisenhower in Europe, and Mark Clark succeeded Ridgway in the Far East. On May 27 in Paris, representatives of the Federal Republic of Germany joined those from the Benelux countries, France, and Italy in establishing a European Defense Community (EDC), a single-command organization, linked to Britain and headquartered in Paris, that reported directly to NATO. France did not ratify the agreement. Separate understandings promised West Germany full sovereignty, an end to Allied occupation but retention of military rights there, and acceptance of money and armed forces from the Federal Republic for NATO's defense of Europe. Britain and the United States agreed to maintain indefinitely their garrisons in Europe. Although Truman signed in August a protocol to the North Atlantic Treaty that extended its defense guarantees to include the EDC, the French National Assembly rejected the EDC. On August 1, France agreed to "Europeanize" the Saar and include it in the joint coal-steel agreement. The initial session of the European Coal and Steel Community's council voted on September 10 to try to extend the economic group to the political realm; that effort ended when the Bundestag declared the Saar election illegal and refused to recognize its pro-French results.

Truman's budget message to Congress on January 21, 1952, estimated for fiscal year 1952–53 Federal expenses of $85.4 billion, receipts of $71 billion, and a deficit of $14.4 billion, all sums except the last one greater than those in 1951–52. The $27 billion he proposed for natural-resources expenditures, $543 million less than in 1951–52, included $29 million, a $1 million increase, for the USGS. The USGS, with the USBM, continued to "appraise known sources and make surveys for new sources of critically needed materials—such as uranium, nickel, cobalt,

tungsten, copper, and lead—and conduct research aimed at improving mining practice and methods of extracting materials, recovery of secondary metals, and increased efficiency in the use of substitutes."[141] Truman also emphasized his administration's plan to continue research and operate pilot and demonstration plants for producing liquid fuels from oil shale and coal. On February 11, Truman urged Congress to extend and strengthen the Defense Production Act[142] and help expedite the production of bauxite from Jamaica, copper from Chile, and nickel from Cuba. After Truman appointed Manly Fleischmann to succeed Edwin Gibson at the Defense Production Administration, the President nominated Henry H. Fowler as Fleischmann's replacement at the National Production Authority; in September, Truman asked Fowler to follow John Steelman as head of the Office of Defense Mobilization. In other changes in 1952, James Webb resigned as Under Secretary of State and joined Kerr-McGee. When James Boyd left the DMEA and the USBM to become vice president for exploration at Kennecott Copper Company, John J. Forbes replaced Boyd at the USBM. Truman added, on March 6, that the United States required $7.9 billion to finance its foreign aid during fiscal 1952–53. He also repeated, on April 19, his January request for action by the legislators on the St. Lawrence Seaway and Power Project. To ensure continued Federal control of U.S. offshore fuel resources, Truman vetoed on May 29 a Senate Joint Resolution that would have established free titles to the States for the lands and natural resources beneath navigable waters within their boundaries.

Secretary Chapman requested $621.5 million for Interior during fiscal year 1952–53, or about $100 million more than in 1951–52. The new total included $12 million more for the USBM and the USGS, whose exploration programs for strategic and critical materials, Chapman asserted, "should be 10 times as great as they are today."[143] The Bureau of the Budget (BoB) approved for the USGS a SIR total of $29,055,000, a $7.6-million increase over the previous year's sum, to cover the larger salaries required by 1951's Pay Act, the AEC's needs, and the $4.9 million in domestic-mapping funds previously provided by the Army Engineers to expand a strategic effort that was now the USGS' basic responsibility. Managers of the USGS topographic program proposed to map about 4 percent of the 2.5 million square miles not yet covered. Chapman also emphasized the Nation's need for continued discovery of oil reserves in light of American industry's continuing expansion. Eighteen years earlier, Interior and the American Petroleum Institute had reported U.S. known reserves of 21 billion barrels. At the present rate of use, Chapman noted, those reserves would have lasted no more than 15 years. Now, with known reserves of 25 billion barrels, the production rate was 6 million barrels per day or 1 million less than the rate of consumption.

Wrather appeared before the House's Interior subcommittee, chaired by Representative Kirwan, on January 21, 1952, 4 days before Chapman's testimony. Wrather expected the USGS to receive total receipts of $50.9 million from Federal and nonfederal sources, $1 million more than in 1951–52. In supporting the request for the full SIR amount, Wrather and his managers emphasized the significant new discoveries of iron, zinc, columbium (in bauxite), and cobalt, the last two used in manufacturing jet engines. They also reported the increased monies expected from the Army Engineers; the greater air-photo coverage and helicopter-supported triangulation control that enabled up to five-times faster work than originally planned in mapping Alaska's topography; and the increasing requests from the AEC, the USAF, and the NSRB for water-supply data and investigations of sites for industry, bases, and depots. Representative Norrell asked Bill Bradley if the funds provided for studies of Arkansas bauxite, other U.S. mineral resources, and other vital problems, if approved, could be used flexibly. After Bradley said yes, Wrather responded for the rest of the USGS program by emphasizing the need for adequate funds not specifically earmarked "for some specific purpose or project."[144] "That is particularly true," Wrather continued, "in water because the demands for financing water

programs are distributed all over the country." The USGS, he concluded, could make one of its greatest contributions to national welfare

> **if we just had in our budget money which we could hold inviolate, subject to administrative direction on what these pressing problems are, allowing us the opportunity to study the situation and reach sound conclusions.[145]**

The House Committee on Appropriations approved the full amount recommended by the subcommittee, but, on the House floor, Representative William M. Colmer (D–MS) proposed an amendment to set the appropriation at the previous year's figure. In opposing the change, Kirwan urged his colleagues to remember the needs for running the Nation and its defense and vote down the amendment. Instead, the House passed the modification and selected $25,362,685 to represent the last year's appropriation. The legislators, in doing so, may have misread the data in the justification that gave the total available for fiscal year 1951–52, excluding the pending estimate for pay raises. Carl Hayden's Senate subcommittee on Interior's appropriations heard Chapman on April 16. The Secretary asked the subcommittee to restore to the USGS in full the nearly $3.7 million cut, an amount 5 percent below the current appropriation, on the House floor, but Senator Cordon urged his colleagues to keep the 1951–52 level. Wrather and his administrators appeared on April 25 and asked for a full restoration by activity; otherwise many operations including the work on high-temperature metals and the strategic mapping would be delayed. The USGS, Wrather testified, could not absorb the costs. In response to Hayden's query about the topographic work, FitzGerald said that even with full funding and the technological advances "It will take us about 30 years"[146] to map the conterminous United States but that the coverage of Alaska would be completed in 6 to 8 years. When Hayden asked about the value of transferred versus direct funding, Wrather pointed out the former's unreliability, using as a recent example the Army Engineers' reduction in their transfer funds that caused the USGS to "drop 75 gaging stations operated for flood control." He emphasized that

> **our problem is keeping a competent and efficient organization capable of dealing adequately with a fluctuating workload which results from depending too extensively on transferred funds.[147]**

The full Senate proposed a further reduction in USGS funds to $25,301,000 but, in the end, it accepted the House's figure. The conference committee recommended distributing the USGS appropriation among its activities as set out in the Senate's report, except to reduce the amount for topographic surveys by $138,415 and increase that for water-resources investigations by $200,000. The legislators agreed to fix the final figures for direct appropriations for fiscal year 1952–53 at $25,362,685. That total included $11,306,585 for topographic surveys, $5,810,000 for geologic and mineral-resources surveys and mapping, $6,187,000 for water-resources investigations, $43,700 for soil and moisture conservation, $360,000 for land classification, $1,080,000 for supervising mineral leases, and $575,400 for general administration.

As Interior's budget for fiscal year 1952–53 neared approval, the President's Materials Policy Commission, chaired by William Paley, transmitted to Truman on June 2, 1952, its report, the five-volume "Resources for Freedom," and the President sent it on to Congress. The Paley Commission's "major premise" held that

> **[t]he over-all objective of a national materials policy for the United States should be to insure an adequate and dependable flow of materials at the lowest cost convenient with national security and with the welfare of friendly nations.[148]**

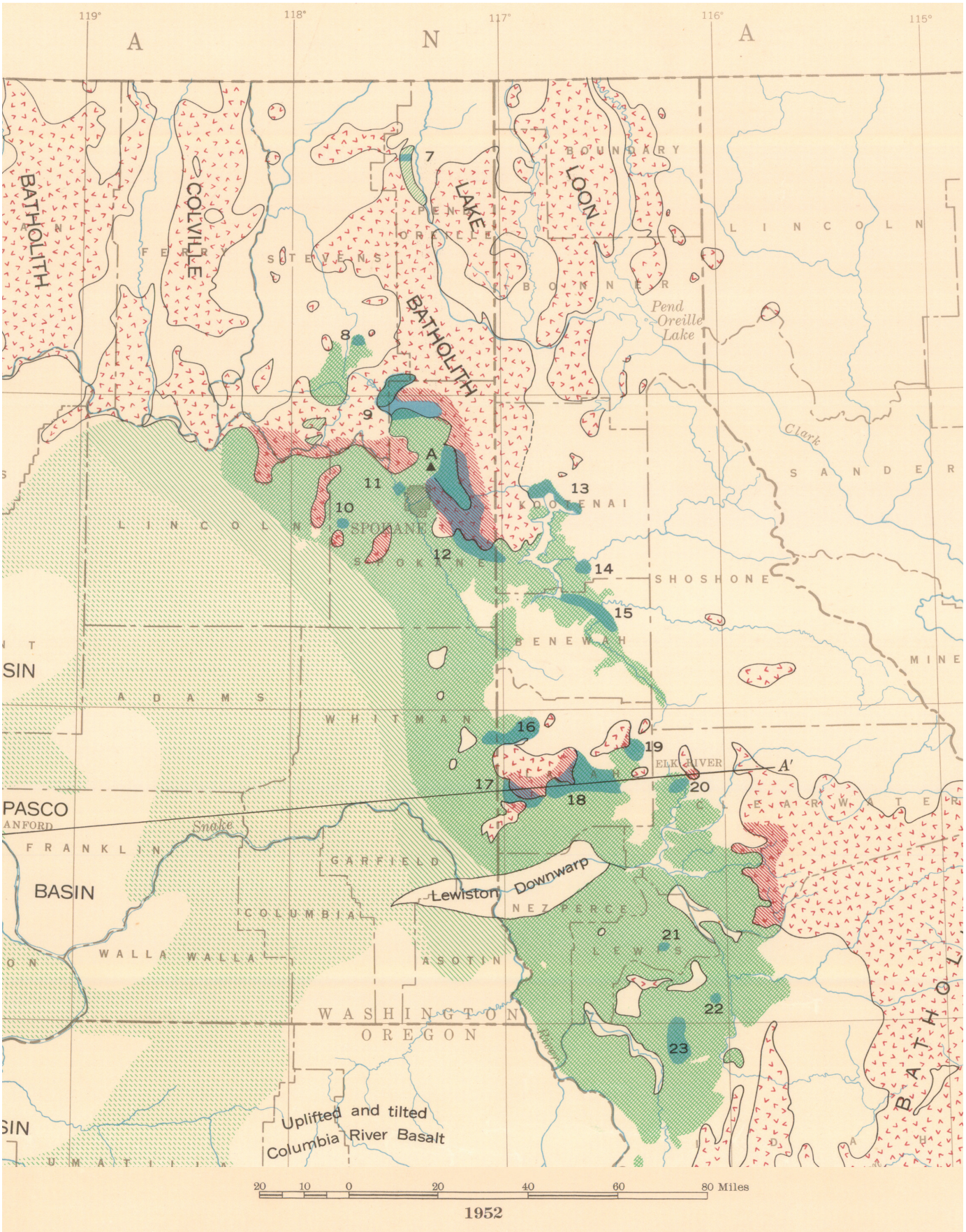
The Commission emphasized, as its "most important conclusion," that

> **the job must be carried on cooperatively by Government and private citizens, not periodically at widely spaced intervals, but day by day and year by year.[149]**

The Paley Commission estimated that materials consumption would increase by 153 percent in the next 50 years, minerals use would rise twice as fast as the total of all other materials, materials demand by the United States compared to that of the rest of the free world would increase unevenly, and, although new and substitute materials would be produced, that the Nation would become a net importer of other key resources besides copper, lumber, petroleum, and zinc. The Commissioners hoped that new discoveries, sufficient energy resources, and new technology would counter expected continuing rises in prices. The Commission's report, in discussing mineral, timber, agricultural, and water resources, represented the most comprehensive treatment ever given to the material-resources problem.

The Commission, in asking for "more facts and better analysis," recommended strengthening the program-analysis staffs and fact-gathering and analytical abilities of Interior's Office of the Assistant Secretary for Mineral Resources, the USBM, and the USGS "to develop and maintain a comprehensive appraisal of the minerals and energy position and prospects of the United States and the free world."[150] The Commissioners emphasized "an impelling need to accelerate the topographic and geologic mapping of the United States and Alaska." They called the current rate of progress on adequate-scale mapping to support mineral discoveries of one-half of 1 percent of the total land mapped in a year "pitifully inadequate to the Nation's needs."[151] They suggested that personnel shifts and new recruitment "might be possible to increase the rate of geologic map making by 50 percent in 5 years, and to double it in perhaps 5 years more." "Similar increases," they added "could be made in topographic mapping."[152] The Commissioners recommended that direct exploration for minerals by the USGS and the USBM should "be limited to those situations in which the national interest requires enlargement of reserves or knowledge about reserves but in which the risks are so great or the promise of reward in a reasonable period so small that private industry cannot be expected to undertake the work." In that mode, the two agencies would "anticipate and seek to avert emergencies rather than responding to them after they have developed."[153] That view and the recommendation that "stockpiling of strategic and critical materials [from all available sources and to the fullest possible levels] be made a permanent instrument of the national materials policy of the United States," including "the provision of adequate funds at all times for orderly purchases commensurate with possible emergency needs"[154] and the prohibition of withdrawals other than in times of national-security emergencies, demonstrated that the Commissioners also had learned the minerals lessons of World Wars I and II and the Korean conflict.

The Paley Commission focused much of its effort on metallic and nonmetallic minerals. In August 1951, the Truman administration lifted controls on asbestos, beryllium, columbium, fluorspar, graphite, kyanite, manganese, mercury, and tantalite (tantalum ore); it also centralized purchases of rubber and tin to reduce their inflated prices and build their stockpiles, but the efforts met with mixed success. The Paley Commission's second volume, edited by Lasky, contained the results of a long-range survey of prospects in the United States and the rest of the free world for 30 key commodities, of which most were minerals. They included aluminum, antimony, beryllium, bismuth, chromium, cobalt, columbium, copper, fluorspar, lead, magnesium, mercury, mica, molybdenum, nickel, quartz crystals, sulfur, tin, titanium, tungsten, vanadium, zinc, and zirconium. The fourth volume contained evaluations of the promise of improved exploration that combined geochemical,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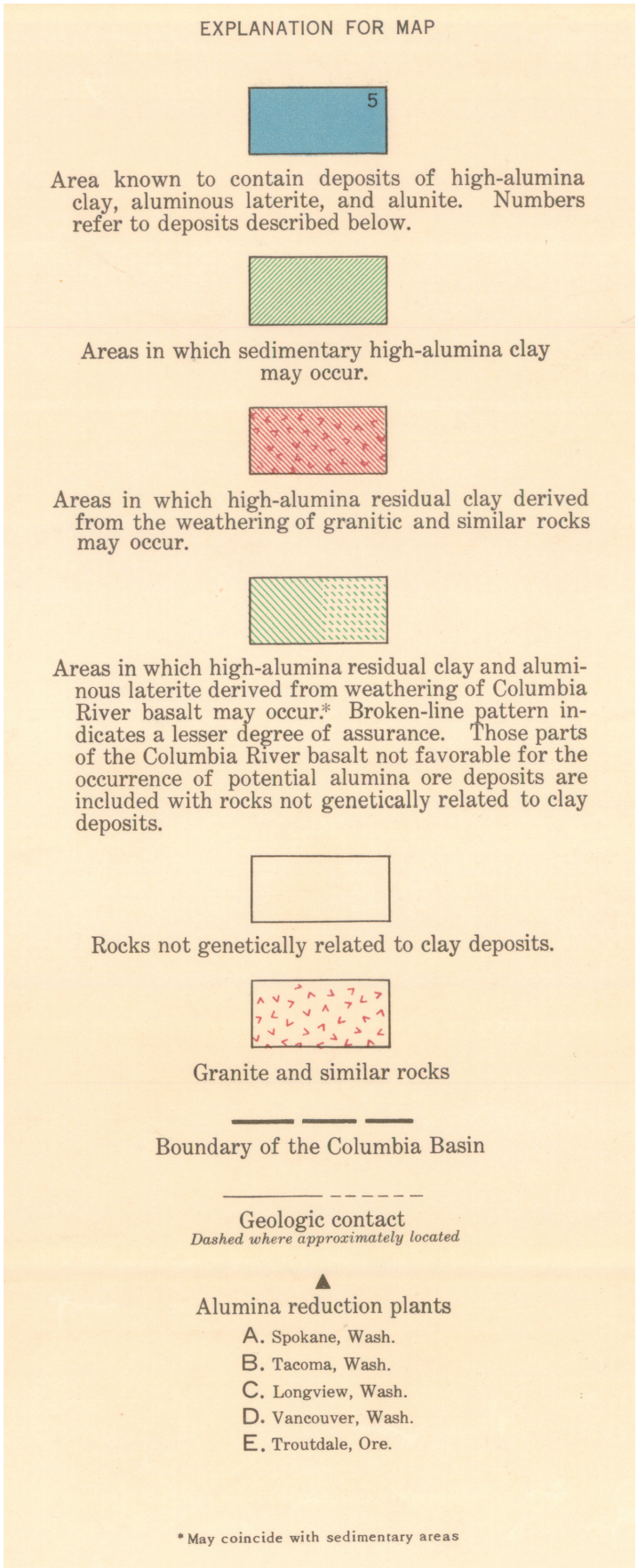


This part of Mineral Investigations Resource (MR) Map 1 (originally at 1:1,500,000) shows the geologic environment of alumina resources near Spokane in the Columbia River Basin, which encloses major portions of Idaho, Oregon, and Washington and minor parts of Montana, Nevada, and Wyoming. The map shows the areas having known potential resources and the areas in which other deposits might occur. The numbers (8–23) on this part of the larger map denote the locations of known and described deposits of high-alumina clay, aluminous laterite, and alunite, which also contained lesser but recoverable amounts of gallium, iron, and titanium. The increased use of aluminum during and after World War II led to a greater interest in U.S. sources of aluminum other than bauxite. The alumina-reduction plant at Spokane (A) was one of five facilities then producing aluminum in the Columbia Basin. The Mineral Investigations Resource Map series began in 1952, and MR 2 appeared in 1955. (From Sohn, 1952.)

geophysical, and photogeologic methods; mining-law revisions; new materials and technology; recycling; and substitution for increasing the supplies of these and other materials. Minerals "scarce in relation to their use"[155] included antimony, beryllium, bismuth, cadmium, cerium, chromium, cobalt, columbium, copper, fluorspar, germanium, gold and other noble metals, lead, manganese, mercury, molybdenum, nickel, platinum, radioactive metals, selenium, tantalum, tin, tungsten, vanadium, and zinc. Others, "both scarce and undeveloped,"[156] included cesium, gallium, hafnium, indium, lithium, rhenium, strontium, tellurium, thallium, and the rare earths. The report of a National Research Council (NRC) panel, requested by the Commission and enfolded into the fourth volume, emphasized that "abundant reserves of undiscovered minerals" lay "within economically accessible depths below the surface" and that "adequate research and development" could produce "exploration techniques capable of locating a large part" of these ores. The NRC panel suggested three main "lines of attack on the exploration problem."[157] Its members recommended determining the temperature and pressure of depositional solutions, the chemistry of mineral formation, and the significance of the nature of wall-rock alteration and alteration suites. They also listed testing color photography in regional geobotanical and geological studies (using colored or dichroic stereoscope filters in laboratory experiments to highlight diagnostic color indicators), expanding the principles of photogeology, and increasing coverage by detailed aerial photography. The panel also urged adapting known methods and devising new techniques of geophysical prospecting, including designing and developing new equipment for generating and measuring electromagnetic signals, conducting airborne electromagnetic surveys, and investigating natural potential differences.

In assessing the Nation's energy problem, the Paley Commission's first and third volumes, the latter also edited by Lasky, evaluated limited supplies and rising demands in looking at coal, natural gas, nuclear fuels, oil, oil shale, solar energy, and waterpower. The American Petroleum Institute (API) reported on March 12, 1952, a domestic production of 2.2 billion barrels of crude in 1951, compared to the yearly average of almost 1.9 billion barrels in 1946–50; proved reserves of 27.5 billion barrels, not including natural-gas liquids, compared to 23.1 billion barrels in 1946–50; and new discoveries and developments that yielded 4.4 billion barrels, compared to 2.9 billion barrels during 1946–50. The American Association of Petroleum Geologists (AAPG) noted that since 1944, the ratio of dry holes to successful wells in wildcat fields had remained constant at 8 to 1. *World Oil* reported increases in 1951 of 37 million feet drilled and 1.9 barrels of proved reserves per foot drilled. The United States continued to produce, as a percentage of its known reserves, nearly three times that of all the other countries in the free world. The Commissioners projected, on the basis of information from the API's Committee on Petroleum Reserves, the USBM, and other sources, that the Nation's demand for petroleum would increasingly outpace domestic production through 1975, whereas the latter would likely peak in 1963 or 1967 and then decline slowly or more rapidly, although the third scenario showed a continued rise. America's present use of 6.5 million barrels of oil each day, they suggested, would increase to 13.7 million, or about 110 percent, by 1975, as the total demand of the free world rose from 10 million to 26.8 million barrels, or nearly 170 percent. The Commissioners knew that new domestic discoveries of significant structural and major stratigraphic oil fields continued to be made. Perhaps additional supplies would come from secondary recovery methods in existing fields; commercial quantities of synthetic oil, within 10 years from oil shale and then from coal; and rising imports from greater reserves proved by increased drilling in the Middle East and elsewhere to make up the shortfall of 2.5 million barrels per day in net imports in 1975, up from 545,000 each day in 1950.

The Commissioners, in urging a national policy for energy and other material resources, argued that petroleum reserves for times of war would be helped most

by an "'underground stockpile' of semiproved oil deposits which could be drilled up as required with maximum speed and at minimum expenditure of materials and manpower on 'dry holes.'" As the Continental Shelf, "particularly that section off the Gulf Coast," provided such an area, they recommended that "the Federal Government encourage immediate exploration for oil on publically owned offshore lands."[158] On January 16, 1953, Truman responded by issuing an Executive order setting aside the oil-rich submerged lands of the Continental Shelf as a naval petroleum reserve,[159] stating, as he did so, his belief that all its oil and gas belonged to citizens of the United States and not just those of California, Texas, and Louisiana. The Commissioners concluded "that the most important step for Government to take at this time toward developing a comprehensive energy policy is to achieve, through a single agency, a comprehensive and continuing review of the long-term energy outlook and an appraisal of the adequacy of public and private policies and programs for coping with the problems."[160] They recommended funding the NSRB as the central agency for collecting and evaluating "the facts, analyses, and program plans of other agencies on materials and energy problems and related technological and special security problems," recommending "appropriate action for the guidance of the President, the Congress, and the Executive agencies,"[161] and reporting annually to the President the long-term outlook for, changes in, new problems about, and necessary modifications of materials policy and publicizing it to the degree consistent with national security.

The most significant problem in water resources, the Paley Commission asserted, remained the large differences in the availability to and the use by the States of surface water and groundwater. The 17 westernmost States occupied about 60 percent of the Nation's land area, but they held only about one-fourth of its water supply. The Western States averaged less than 4 inches of runoff per year, compared to 16 inches for the 31 Eastern States. Water use, the Commissioners noted, also remained a regional rather than national problem, as industrial consumption remained heaviest in the Northeastern States compared to municipal, rural, and agricultural uses. The Commissioners estimated that industrial demands for water would rise from 80 billion gallons per day in 1950 to 200 billion gallons in 1975, and the total of domestic, industrial, and irrigation requirements would increase during the same interval from 185 billion to 350 billion gallons each day. New resources, they suggested, might come from reclaiming used water, additional regulation of streams, developing new groundwater reservoirs and artificially recharging existing ones, reducing losses from evaporation and transpiration, importing and desalinizing water, chemically seeding clouds to induce rainfall, and using substitutes for freshwater as industrial coolants. In formulating a general national policy for water resources and conducting programs for their use, the Commissioners recommended following five principles: (1) basing planning and development on all aspects of "collection, conservation, and use"; (2) employing "integrated action in each major drainage basin"; (3) applying the "highest economic use" to "scarce supplies"; (4) ensuring that benefits exceeded costs; and (5) requiring "known beneficiaries" to "help pay for improvements." The Federal Government, they suggested, could contribute best "to improving and increasing water supplies in three main areas:" through "basic studies and technological research," integrating all of its "multiple-purpose"[162] basin programs, and cooperating in all efforts to control and reduce pollution, which they believed to be the true nationwide problem. The Paley Commission, like the President's Water Resources Policy Commission, supported the Hoover Commission's recommendation for a Federal review board to "appraise the costs and benefits of proposed Federal development projects from a comprehensive national viewpoint."[163] The Paley Commission's report on water and other material resources also helped to establish Resources for the Future, a watchdog organization founded in 1952 and quartered in Washington but later moved to Baltimore.

Truman signed Interior's appropriations bill into law on July 9, 1952. On July 15, he also approved a supplementary $3.1 million for carrying out functions under the Defense Production Act. The USGS managed a total of a little more than $48 million for fiscal year 1952–53, a static figure only $5,400 beyond the sum supplied for 1951–52. The monies for 1952–53 included the direct appropriations of nearly $25,363,000,[164] or about 52 percent of the total available; $24,761,000 actually was received. Other Federal agencies transferred about $17,467,000, States and their political subdivisions supplied about $5,583,000, the sale of personal property provided nearly $129,000, the Federal Power Commission's (FPC's) permittees and licensees shifted about $70,000, and the sale to the public of aerial photographs and photographic copies of records generated nearly $47,000. The AEC topped the list of Federal transferees by providing $7,750,000, the largest sum yet sent by the AEC and $2.5 million more than it shifted in 1951–52, which increased its influence on the direction of USGS programs. The DoD transferred just under $3,873,000. That total, representing a net loss of $4.4 million, included nearly $2,207,000 from the Army and its Engineers but, as expected, nothing for topographic surveys; about $1,043,000 from the USAF; and a little more than $623,000 from the Navy. The USBR shifted nearly $3,505,000 (or about $400,000 less than in the previous year); the Mutual Security Agency generated $604,000, the DMEA provided some $472,000, and the TVA supplied nearly $100,000. The State Department, the BIA, and the DMPA transferred a combined $268,000 and other Federal agencies furnished $880,000.

As the new fiscal year began on July 1, 1952, the USGS employed 7,717 people; 6,368 of them were classified as full time, 259 were part time, and 1,090 were field assistants and laborers. The USGS had gained 800 persons, all of them full-time employees, since June 30, 1951. Of this number, 461 persons served in the Director's Office. The $3 million increase in direct appropriations for fiscal year 1952–53 enabled the USGS to expand its staff and some of its facilities to meet the demands of national defense, but this work already strained the agency's existing resources and now further impeded its regular program. The USGS continued to incorporate areal as well as functional considerations in its budget process. Ground was broken on March 27, 1953, for the new Pacific Coast Center scheduled to be completed by October 1. By then, Wrather and Nolan, who approved regional offices but not regional administration, centralized several support activities. Survey orders on February 17 established two new and major units, an Administrative Division and a Publications Office,[165] to which were reassigned many members of the Director's Office. The Administrative Division, led by its Chief Glendon Mowitt, the former Executive Officer, included the Accounts Branch, the Budget Office, the Organization and Management Office, the Rocky Mountain Service and Supply Branch, and the Service and Supply Branch for the other geographical regions. Wrather's memorandum of June 23 to the Division Chiefs stated a principal objective for each of the five Divisions and similar objectives for the principal operational Branches and Regions.

For fiscal year 1952–53, Bill Bradley changed the titles of his two Assistant Chief Geologists; Harold Bannerman became the ACG for Program, and Esper Larsen 3d became the ACG for Operations. The Geologic Division, on June 30, 1952, employed 1,761 people; 1,506 of them served full time, 152 others were part time, and an additional 103 were field assistants and laborers. The new total represented a net gain during the past year of 168, reflecting an increase of 200 full-time employees and a loss of 32 part-timers. Funds received by the Geologic Division from all sources for geologic and mineral resources surveys and mapping during fiscal 1952–53 provided almost $15,973,000, a net increase of some $1,172,000 over the previous year, due principally to the AEC's addition of slightly more than $1,368,000 to the funds it transferred in 1951–52. Direct appropriations

provided about $5,556,000, a loss of nearly $207,000 from 1951–52 and a sum representing only 35 percent of the Division's total funds, continuing the decline in the ratio between SIR monies and transferred dollars. The AEC's funds alone, now at their largest level yet of nearly $7,168,000, represented 45 percent of the Division's total receipts and 70 percent of all its Federal transfer funds. The Army and its Engineers, the Navy, the BIA, the DMEA, the MSA, and other Federal agencies increased their transfers by a total of nearly $580,000, while the USAF, the USBR, and the DMPA reduced theirs by only $52,500. For the first time since fiscal 1941–42, the Geologic Division did not include in the USGS annual report for fiscal 1952–53 a specific amount of transfer funds from the USBM.

A Survey order on March 19, 1953, confirmed the Chief Geologist's responsibility for appointments to and operations by the Geologic Names Committee.[166] The reorganized Committee would include a Chairman, George Cohee, later known as "Judge," and not more than seven geologists, plus the Chief of the Paleontology and Stratigraphy Branch as an ex officio member, one geologist each from the Conservation and Water Resources Divisions, and temporary advisers and specialists on stratigraphic problems. The order also specified nine rules for the USGS administration of the classification and nomenclature of rock units, especially as they related to their use in manuscripts and appeals of the Committee's decisions to the Chief Geologist and the Director.

The Mineral Deposits Branch in fiscal year 1952–53 carried out 86 projects in 36 States, guided in part by Bannerman's white paper on Federal responsibilities for mineral exploration that highlighted a crisis in strategic and critical minerals he believed approached that of World War II.[167] Branch teams continued their exploratory geology and drilling in the lead-zinc district of Wisconsin and Iowa, in the Mojave Desert, and on the Colorado Plateau. Regional studies of mineral resources continued under the sponsorship of the two interagency committees—one for New England and New York and the other for the Arkansas, White, and Red Rivers. Branch geologists, financed by the DMEA and the DMPA, and working with USBM engineers, extended their evaluations of applications for mineral-development loans to private owners and provided the technical advice needed to enforce the contracts. Increased funding by the AEC facilitated enlarged physical exploration and geologic studies on the Colorado Plateau that identified new deposits of radioactive minerals of significant size and increased known reserves, as the Branch's work expanded to meet the AEC-mandated goal of 1 million feet of drilling each year. Related investigations in Colorado's Central City district by Paul K. Sims, newly joined Avery A. Drake, Jr., and their colleagues yielded two discoveries of potentially important uranium deposits.

Additional field investigations by Branch members during the year, especially those in the West, led to other discoveries. Long-term geologic mapping in the Black Hills by Jack A. Redden and other geologists helped to locate a beryl deposit that produced 250 tons of the beryllium-bearing mineral during 1952–53, a volume nearly 40 percent of the year's domestic output. Additional detailed geologic mapping by Earle Cressman, Richard Sheldon, Roger Swanson, and their colleagues in the Idaho-Wyoming phosphate region found a significant bed of phosphate rock; although low in grade, the bed proved widespread and as much as 12.5 feet thick. Arthur R. Kinkel, Jr., assisted by Wayne E. Hall and John P. Albers, continued mapping begun in 1946 in the Shasta copper belt near Redding. Their work and subsequent diamond drilling, both in cooperation with the California Division of Mines, disclosed mineralized ground that contained important amounts of copper and zinc sulfides. Studies in Minnesota's Cuyuna Range, coupled with laboratory development of a new technique for field use, led to devising a method to distinguish between similar-appearing slates in hanging walls and footwalls on the basis of a rapid chemical test for the alumina-titania ratio. This method, if found reliable, would reduce by up to 30 percent the number of drill holes required in exploring

for new iron-ore deposits. Branch specialists also prepared a report on the iron-ore reserves for presentation among the other USGS-authored papers at the 19th International Geological Congress (IGC) in Algiers during September 1952. William Johnston represented Director Wrather at the 18th IGC in London in 1948,[168] but Wrather led the U.S. delegation to the 19th IGC in 1952.[169] Wrather participated in a pre-IGC coastal and inland excursion, but the "steel-frame corset [worn] for the ailment that later incapacitated"[170] him prevented his joining a postmeeting trip to mountains more than 800 miles south in the Sahara.

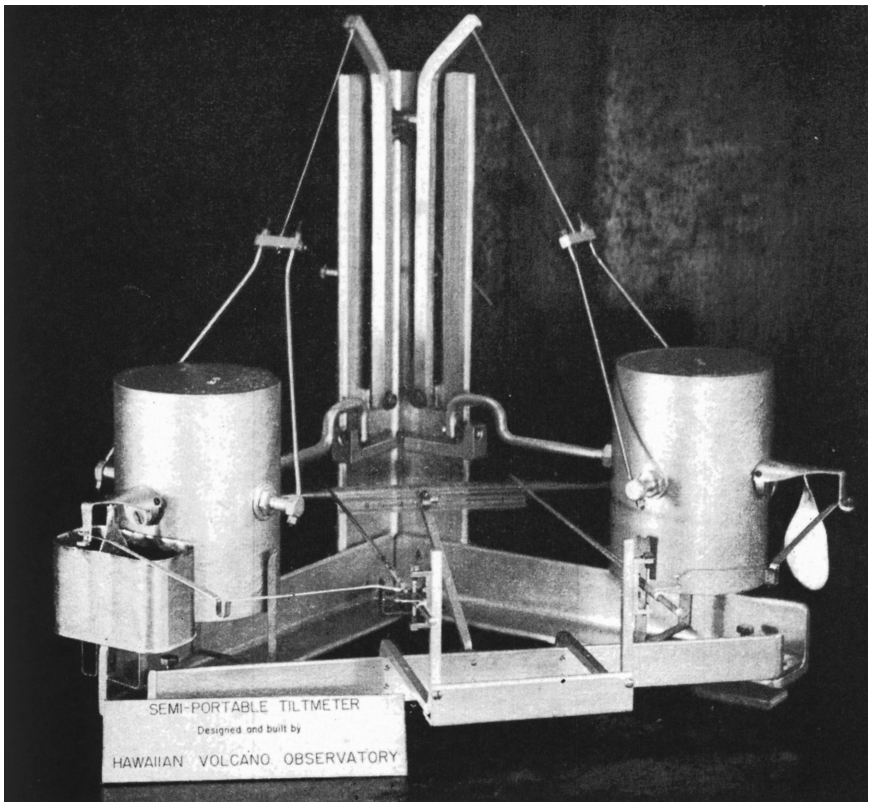
Fuels Branch members, after consulting with the oil and gas industry, State geological surveys, and other agencies, continued or began during fiscal year 1952–53 more than 20 regional studies in 16 States having known or potential petroleum resources. James Vine and the Conservation Division's Charles E. Erdmann published an oil and gas map of Montana on two sheets at 1:500,000. Investigations of oil-shale deposits in Colorado and Utah led to estimates that the shale in the mapped areas might yield as much as 79 billion barrels of oil. Branch geologists studied coal deposits in 17 States, and Andrew Brown and his colleagues published summary reappraisals of reserves in Colorado, North Dakota, South Dakota, and Virginia. For the AEC, Branch geologists made reconnaissance searches and several detailed studies, some accompanied by core drilling, in 17 States to obtain information on the distribution of coals containing radioactive materials. Branch members continued to investigate high-grade deposits of oil shale in Colorado and Utah, completed reports on areas totaling 635 square miles that held estimated reserves of up to nearly 80 billion barrels of oil, and filed an AEC-sponsored report on radioactive oil shale in the Southeastern States.

During fiscal year 1952–53, Division geologists mapped in 17 States and the Territories of Alaska and Hawaii as part of more than 20 ongoing or new projects. Two volcanic eruptions in these Territories drew public attention and helped to maintain support for the General Geology Branch's volcano-studies program. In Hawaii, Kilauea Volcano erupted in June 1952, and eruptions continued into November. Activity at Kilauea in 1952 was observed in detail by Gordon Macdonald and other geologists at the HVO, which had been relocated in 1948 from the northeast rim of Kilauea caldera to the northwest rim. On February 15, 1953, an eruption of Mount Trident, a triple-peaked volcanic complex 5 miles southwest of Mount Katmai on the Alaska Peninsula and about 275 miles southwest of Anchorage, sent an ash cloud to an altitude of 30,000 feet and later to 35,000 feet. Ray Wilcox sent geologist George L. Snyder, a former Navy pilot, to Kodiak to add his observations from USN aircraft to those made by USAF, U.S. Coast Guard (USCG), and commercial-airline crews. During February 25–March 13, and on June 17, Snyder, aided by Geophysics Branch seismologist Richard R. McDonald, studied the eruption, including the lava issuing from the southwest-side vent. Activity ended on June 30 without posing dangers to civilian or military installations.[171] Snyder then transferred to George Fraser's Eastern Aleutians Project. In May, the scientists at the USGS facility on Adak reported a mild eruption of Great Sitkin Volcano northeast across Kuluk Bay from Adak.

In fiscal year 1952–53, members of the Alaskan Geology Branch mapped areas in the lower Kuskokwim region, extended studies of copper mineralization near Prince William Sound, looked in detail at tin deposits and tungsten mineralization on the western Seward Peninsula, investigated perlite and diatomite occurrences in the area of Mt. McKinley (Denali) National Park, mapped power sites on the Kenai Peninsula, and searched for fissionable materials throughout the Territory, supported by a seasonal radiometric laboratory at College, Alaska. Engineering geologist George Plafker, who served with the Army Engineers and the Military Geology Branch before transferring to the Alaskan Geology Branch to work with Don Miller in the Gulf of Alaska Tertiary province, examined for the Conservation Division waterpower sites on the Kenai Peninsula during August–September 1952.

Farrell Barnes, Clyde A. Wahrhaftig, and other geologists continued the Branch's investigations of coal deposits in the Matanuska, Nenana, Susitna, and other fields. Results of Branch investigations led to the increases in the estimates of the Territory's inferred coal reserves; those in the Alaska Railroad belt rose by several million tons, including those recoverable by strip mining. Branch geologists also appraised the petroleum possibilities of areas near Nelchina, on the eastern slope of the Talkeetna Mountains, northeast of Anchorage, near the northeast end of the Cook Inlet-Susitna Mesozoic province, and in northern Alaska, including NPR–4.

Planning for the 1953 season in NPR–4, likely to be funded at only $4 million, began in Fairbanks during October 1–3, 1952, at a meeting attended by John Reed (Sr.), and continued at the regular meeting of the Advisory Committee, November 18–19, in Denver. George Gryc reported results of stratigraphic zonation and correlation of the North Slope's Cretaceous sequence and the work required for completing the interpretation. Drilling proposed for 1953 included two principal wells to test anticlines—a 10,000-foot penetration into pre-Cretaceous rocks at Shaviovik and a 7,000-foot well at Brady—supported by the work of one seismic crew and one of the three geologic parties. The other two geologic parties would examine the Kuparuk and Katakturuk areas, but all authorized and proposed photogeologic mapping would end, except for work on the Brady, Kuparuk, and Rex anticlines and the Cape Lisburne area. Results of coming discussions with congressional committees, Captain Meade noted on December 31, "might require the presentation of closeout alternatives."[172] When Robert B. Anderson, the new Secretary of the Navy, told the House Committee on Armed Services on March 6, 1953, that he intended to close out the exploration program in NPR–4, its members approved that decision. The Executive Operating Committee, meeting in Washington on March 10, determined which equipment would remain in NPR–4 and authorized the seismic party at Shaviovik to complete work needed to interpret the anticline; it was finished by early April. The Committee also decided to close the USGS



USGS scientists and technicians at the Hawaiian Volcano Observatory (HVO) designed and built this semiportable tiltmeter for use by HVO researchers in Hawaii and by members of the Aleutian Volcano Investigations Unit on Adak (1949–54). The instrument weighed about 90 pounds, and its upright post (at rear) was 16 inches tall. The tiltmeter originally was not equipped with a chronograph. It was housed "in a 20-inch cubical weatherproof box" that was installed on a concrete base. The tiltmeter had "a lever magnification of 15." When it was "operated with a period of 20 seconds a 1-millimeter shifting of the lever pointer" indicated "a tilt of 0.08 seconds of arc." (Quotations and photograph from Finch and Macdonald, 1951, p. 108–109 and fig. 34.)

Navy Oil Unit's Fairbanks laboratory in July but to fund a geological party to check specific structures to aid in completing the final report and support it by providing $575,000 in Navy funds through calendar year 1955. The Navy and Interior Departments agreed to turn over to the USGS the Navy's housing, offices, and warehouse at Fairbanks, where the cores and cuttings would be classified and stored as a reference collection. Members of the Pick and Hammer Club's annual show on May 2, 1953, marked the Navy Oil Unit's passing by borrowing Irving Berlin's title tune from his 1942 revue "This is the Army" for their "Home Groan Blues":

> **This is the Survey, Mr. Gryc,**
> **This is the place you won't get rich.**
> **You showed the Navy what rocks are for,**
> **But you can't drill for oil anymore.[173]**

Wrather accompanied Meade's inspection party when it visited Barrow and NPR–4, during July 3–4, to review closeout plans. At Barrow, they encountered the ONR's own inspection group, including Reed, which successfully recommended continuing the town's Arctic Research Laboratory[174] after work ended at NPR–4. Meade completed his tour as DNPR on December 16.

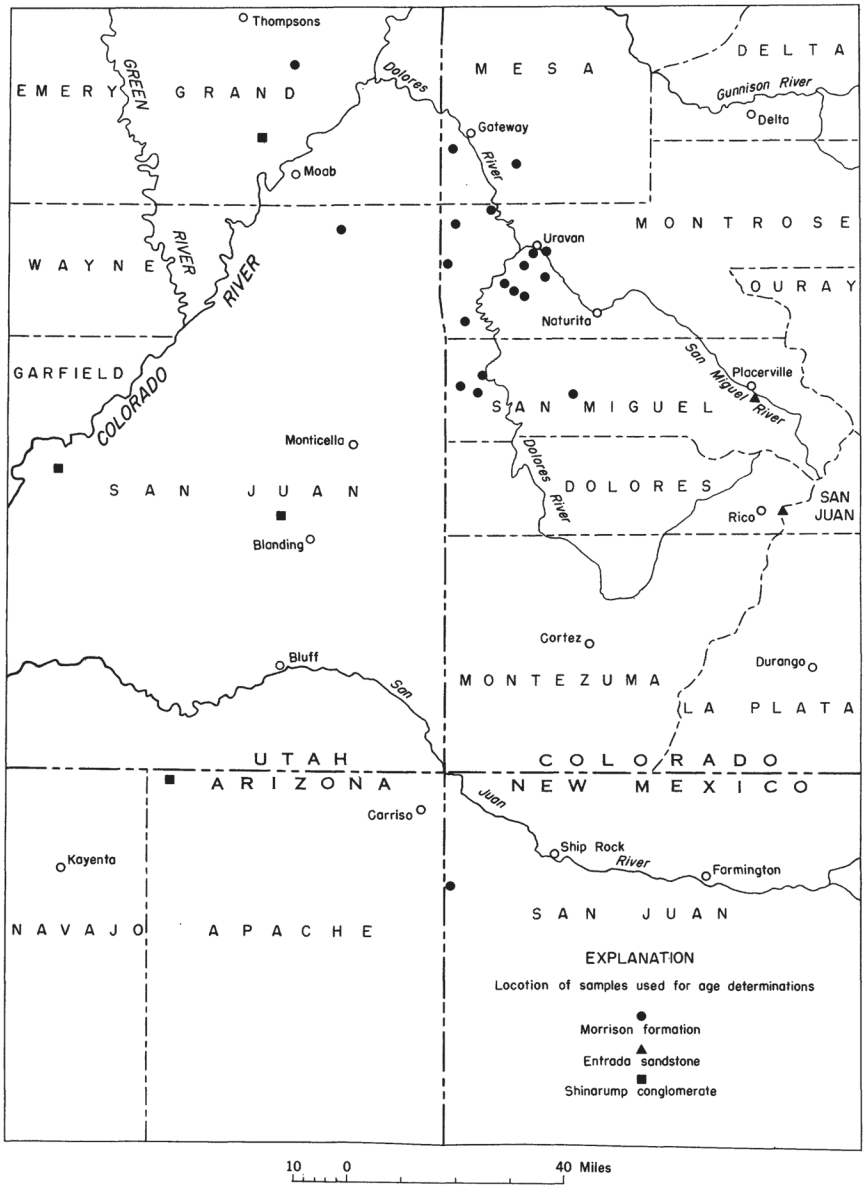
The U.S. Government expended a total of $47.6 million in its decade-long appraisal of the petroleum possibilities of NPR–4 and adjacent areas. Unfortunately, NPR–4 contained no giant oil fields, the industry's "elephants," like Spindletop, or even substantial ones. If important petroleum deposits were present in the Tertiary, Cretaceous, or older reservoir rocks of the Arctic Coastal Plain or the northern foothills of the Brooks Range, they would occur east and (or) south of NPR–4's eastern boundary in North Slope-Coastal Plain areas not yet tested by wells. The NPR–4 exploration program determined the initial "general geologic framework for all of northern Alaska," George Gryc recalled in 1985, "and established the feasibility and practicality of carrying out large-scale modern oil-exploration operations in the Arctic."[175] Drilling in NPR–4 disclosed nine fields, but only one of them contained a significant amount of estimated recoverable oil, the 70 million barrels at Umiat. Two others held useful estimated reserves of natural gas—5 billion to 7 billion cubic feet at Barrow and 22 billion cubic feet at Gubik.

Information from a total of 189,000 square miles of airborne-magnetometer, geologic, gravimeter, and seismic surveys, combined with the 37,000 square miles of trimetrogon photogrammetry of the entire NPR–4, generated an improved understanding of the geology of the Brooks Range and the North Slope. The new interpretations appeared in part on Thomas Dutro's and Thomas Payne's geologic map of Alaska, at 1:2,500,000, published by the USGS in 1954. The Navy also recovered uninstalled equipment and supplies from NPR–4 worth $11.9 million. The installed equipment at Barrow, worth $1 million, went to the ONR's Arctic Research Laboratory, and the equipment at Fairbanks, valued at $99,000, passed to the USGS Alaska center. Operations in NPR–4 also demonstrated conclusively that at times as many as 500 persons could live, travel, and work effectively and efficiently throughout the year in the fragile, harsh, and increasingly strategic Arctic on projects for America's defense and welfare. The USGS added to its support for that effort by issuing a topographic map, at 1:1,000,000, of NPR–4 and the rest of northern Alaska and a flow chart of Arctic work-feasibility conditions influenced by ice, light, and temperature, both as part of Reed's 1958 report on the history of the exploration.[176] During 1955–61, Harlan R. Bergquist, Robert Chapman, Florence R. Collins, Detterman, Dutro, Samuel Keller, Morris, Patton, Payne, Florence M. Robinson, Sable, and their colleagues reported on aspects of NPR–4's Paleozoic rocks; geology of phosphate deposits; geology of the Utukok-Corwin and Shaviovik-Sagavanirktok areas; geology and micropaleontology of cores from test wells in the Barrow, Gubik, Umiat, and 11 other areas; Mesozoic and Cenozoic tectonic elements; and vegetation.

The Geophysics Branch relocated its personnel from Baltimore, during September 1952, to office quarters in Washington and shop facilities in nearby Silver Spring, Maryland. The Branch modified a C–47 aircraft (transferred from the DoD, as N19950) for radioactivity and other airborne-geophysical exploration. In aerial surveys, now directed by William Dempsey (Sr.), over parts of 15 States, Branch geophysicists discovered above-normal radioactivity in Arizona, Florida, and Wyoming and completed a magnetic transect from Indiana across the southern Appalachians to the Atlantic Coast. James Balsley, Bill Bromery, Herbert Hawkes, Jr., John R. Henderson, Jr., Mary Hill, Matt Walton, and other geophysicists continued to conduct surveys and publish aeromagnetic-geologic maps of quadrangles and counties. Data on subsurface stratigraphy and structure obtained during ground surveys in 10 States, Alaska, and 3 areas abroad aided studies of mineral deposits and water supplies. Ground surveys made to delineate recorded aeromagnetic anomalies located new manganese deposits near Aroostook, Maine; others determined the thermal conductivity of permafrost in Arctic regions and aided the interpretation of electrical-resistivity anomalies in the Badger-Peacock mining district in Kansas. Continuing work funded by the AEC included exploration surveys, studies of radon in helium from natural-gas fields, and investigations of the physical and chemical properties of ore and country rock where the interstitial water was unaffected by drilling to aid interpretations of existing geologic and geophysical data and suggest new or modified exploration techniques. The Branch's quarterly journal *Geophysical Abstracts*, now directed by geophysicist Mary C. Rabbitt, began its 25th year of publication.

The Engineering Geology Branch's nearly 20 projects in 11 States continued during fiscal year 1952–53 to emphasize mapping large urban and rural areas in the United States principally to provide information for the planning of construction projects. Branch geologists again worked in the Missouri and Columbia River Basins and began studies on the upper part of the Green River drainage. Geologic mapping and detailed cooperative investigations also continued with Massachusetts and Rhode Island and with the cities and surrounding areas of Denver, Knoxville, Los Angeles, Omaha, San Francisco, and Seattle. The results of general and specific research on problems associated with landslides contributed to a report of landslides and engineering practices by the Highway Research Board's Committee on Landslide Investigations. Engineering geologists investigated for the NPS landslides and sites for relocating roads and tunnels near Mesa Verde in southwestern Colorado. They also cooperated with Ground Water Branch members in studying for the State of California the groundwater conditions on Angel Island in San Francisco Bay.

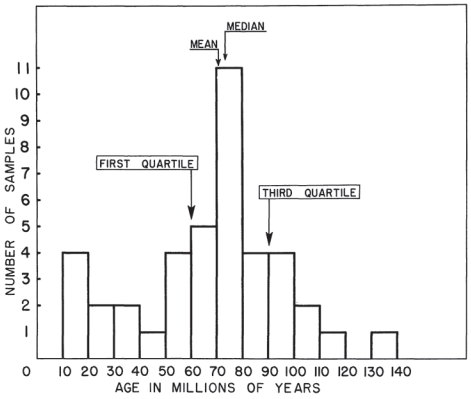
During fiscal year 1952–53, members of the Military Geology Branch continued their work in the conterminous United States, Alaska, the Pacific, Asia, Europe, and Greenland. Branch members completed for the Army Engineers "Geology and Its Military Applications," which appeared in August 1952 as Army Technical Manual 5–545 but remained a classified document until fiscal 1953–54. In Alaska, MGB geologists completed surveys of surficial geology in the Kobuk River area (east of Kotzebue), the Delta River region (southeast of Fairbanks), and the Tok-Mentasta Pass area (along the Glenn Highway south of the Tanana River).[177] Their colleagues continued to map in the southwestern part of the Copper River Basin and began new reconnaissance surveys near Bristol Bay, in the central part of the Kenai Peninsula, and along the route planned for a new road to connect Mt. McKinley (Denali) National Park with the village of Paxson on the Richardson Highway. The staff of the Pacific Geologic Mapping Program finished their work in the northern Marshalls in August 1952, including a reconnaissance of Bikar Atoll, northeast of Kwajalein, and its phosphate deposits. In the Marianas, Joshua Tracey's team continued mapping on Guam and made a reconnaissance of Rota to evaluate and plan for mapping that island in detail. Rota remained under Interior's control after



This map shows the 26 locations on the Colorado Plateau from which 41 samples containing more than 0.1 percent uranium were taken for analysis. Beginning in 1950, USGS geologists used the lead-uranium method to determine (for the U.S. Atomic Energy Commission) the geologic ages of these ores as clues to their origin and aids to further exploration. The ores included uraninite and carnotite from the Shinarump Conglomerate (Triassic), roscoelite (vanandiferous hydromica) from the Entrada Sandstone (Jurassic), and carnotite from the Morrison Formation (Jurassic). Other sampled deposits—from Colorado's Rifle district and Utah's Temple Mountain district—were not plotted on the map. (From Stieff, Stern, and Milkey, 1953, fig. 1; see also the map herein on p. 73.)

an Executive order in November transferred Saipan and Tinian back to the Navy, effective January 1, 1953.[178] MGB members also assessed a volcanic eruption on Kamchatka in November 1952, and completed a study of cross-country movement for tracked vehicles in Pakistan and in India's Punjab State. At the request of the Army Engineers and the Transportation Corps, several members of the MGB went to Greenland during the spring of 1953 to plan for engineering and other special studies on the island.

Continued support from the State Department's Technical Cooperation Administration, the Mutual Security Agency, the Point Four Program, and the governments of other countries enabled members of the Foreign Geology Branch during 1952–53 to continue and expand their studies worldwide, many in collaboration with colleagues in participating countries, and help to train specialists visiting the United States. Branch members extended their long-range investigations of mineral deposits and mineral potential in Brazil, Colombia, Ecuador, Mexico, Paraguay, and Peru. George E. Ericksen completed a 4-year study of lead-zinc deposits in the Hualgagoc and other districts of northern Peru. The Branch added



This histogram of the corrected lead-uranium ages for the 41 samples of ore deposits that contained more than 0.1 percent uranium from deposits on the Colorado Plateau "shows a pronounced maximum in the 70- to 80-million year interval." The analytical and chemical errors in the calculation of each of the geologic ages for the carnotite, roscoelite, and uraninite samples yielded an uncertainty factor of plus or minus 3 million years. The ores' calculated ages, thought to be close to their true ages, indicated that the uranium ores were formed not during the deposition of the Triassic and Jurassic formations, but rather at a later time in the latest Cretaceous and earliest Tertiary (now Late Cretaceous). That model suggested that additional ore would be found at greater depths. (Quotation and histogram from Stieff, Stern, and Milkey, 1953, p. 9 and fig. 7.)

economic geologists Richard G. Bogue, who worked with Herbert Hawkes, Jr., in Nigeria, and Gus H. Goudarzi, who had worked in the Gold Coast (Ghana), to Glen Brown's Point Four Program team in Saudi Arabia to aid in traverse-mapping more of the northern and northeastern parts of the Arabian Shield. Bogue and Goudarzi began detailed studies of minerals and mining along the proposed railroad route from Riyadh to Jiddah. Encouraged by Sheik Ahmad Fakhry's Directorate of Mines, established within Sheik al Hamdan's Ministry in 1946, Brown's team also looked for new or different occurrences at ancient mining sites. Those included Mahd adh Dhahab (Cradle of Gold), rediscovered by Karl Twitchell and other geologists in the 1930s. The Branch also contracted with Aero Service for an additional 68,000 square miles of coverage. Brown also planned during the next 2 years to map most of the remaining areas of the Arabian Shield and the Red Sea Coastal Plain and to drill additional water wells. Branch geologists finished a reconnaissance of metallic-mineral deposits of Burma (Myanmar), Iran, and Iraq and continued to provide technical advice to the members of the Geological Survey of India investigating manganese and other minerals. Branch members also helped to train in field and managerial techniques 40 young leaders, specialists, and technicians from Brazil, Burma, Colombia, Egypt, Greece, India, Mexico, Peru, the Philippines, and Thailand.

The Geochemistry and Petrology Branch during fiscal year 1952–53 completed a mobile spectrochemical laboratory to extend geochemical field investigations to detect minute amounts of significant trace elements as indicators of new areas of potential ore bodies. Branch members also used the lab in studies of disposing of radioactive waste. They advanced their expertise in determining geologic dates by radiometric methods. The Branch founded a facility for dating materials by the radioactive carbon-isotope method developed by 1947 by Chicago chemist Willard F. Libby. This technique, widely publicized in 1952, used the existing ratios of C^{14} to C^{12} in organic materials in a technique found reliable to about 50,000 years before the present. USGS and other geochemists used other known and new isotopic-decay sequences for dating geological materials, techniques usually accurate for intervals equivalent up to about 10 half-lives of the isotopes used. In 1952, Esper Larsen, Jr., promoted the lead-alpha method as an accumulation clock for determining the age of zircons in igneous rocks, while Lorin Stieff and Thomas Stern used lead-uranium ratios from mass-spectrometer analyses to determine the ages of some of the uranium ores from the Colorado Plateau and published preliminary results in 1953. Berkeley physicist John H. Reynolds continued to develop a radiometric method, based on the decay of potassium-40 to argon-40, intended to close the gap between intervals dated by the carbon- and uranium-based methods.

To some earth scientists, the radiometric-dating methods, sometimes inaccurately called "absolute," posed formidable competition to paleontological and other more conventional relative-dating techniques in fossiliferous rocks. Members of the USGS Paleontology and Stratigraphy Branch, who examined during 1952–53 some 60,000 fossil specimens for 550 reports[179] on their biologic affinities, geologic ages, and paleoenvironments, responded as players in the Pick and Hammer Club's show in 1953. To the show-stopping tune "Diamonds Are a Girl's Best Friend," from Leo Robin and Julie Styne's "Gentlemen Prefer Blondes" in 1949, they maintained, in "They Still Don't Make Good Dates," that using fossils, not the new radiometric methods, was the best way to determine the ages of sedimentary sequences. The songsters began with a prelude:

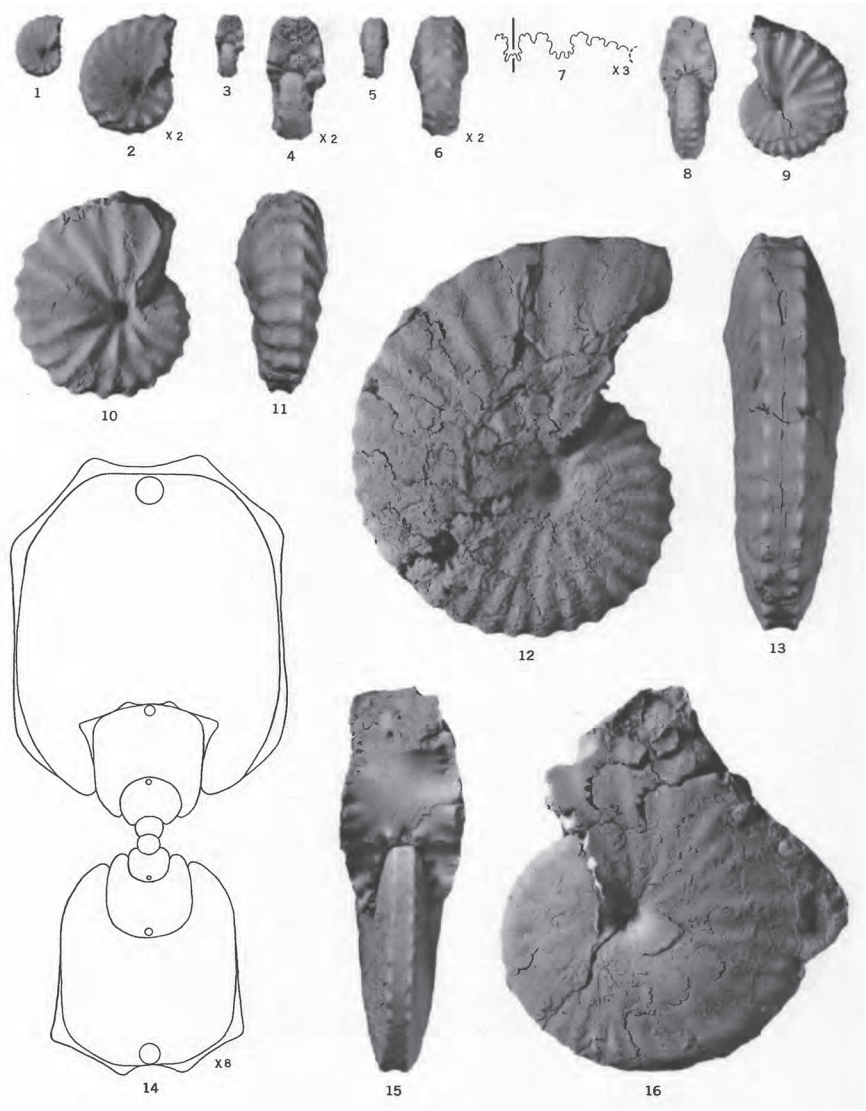
The many ways to date events
Have militant apostles,
But I prefer the evidence
Of diagnostic fossils![180]

Their verses lauded fossils as the "simple key / To orderly stratigraphy," noted that the "Hard rock guys / May theorize, / But they all come to us in the end," eschewed "pebble counts" and other statistical methods, and lastly cautioned:

> **Though the gang gets a bang out of nuclear fission,**
> **Fossils are a churl's best friend.**
> **You can tell where the hell is the late Ordovician**
> **If a trilobite is right in sight to steer you right.**
> **Rocks with lead,**
> **It's often said,**
> **Are a yardstick on which to depend;**
> **But to set up a section by simple inspection,**
> **Fossils are a churl's best friend.**[181]

Igneous, metamorphic, and sedimentary rocks without fossils went unsung.

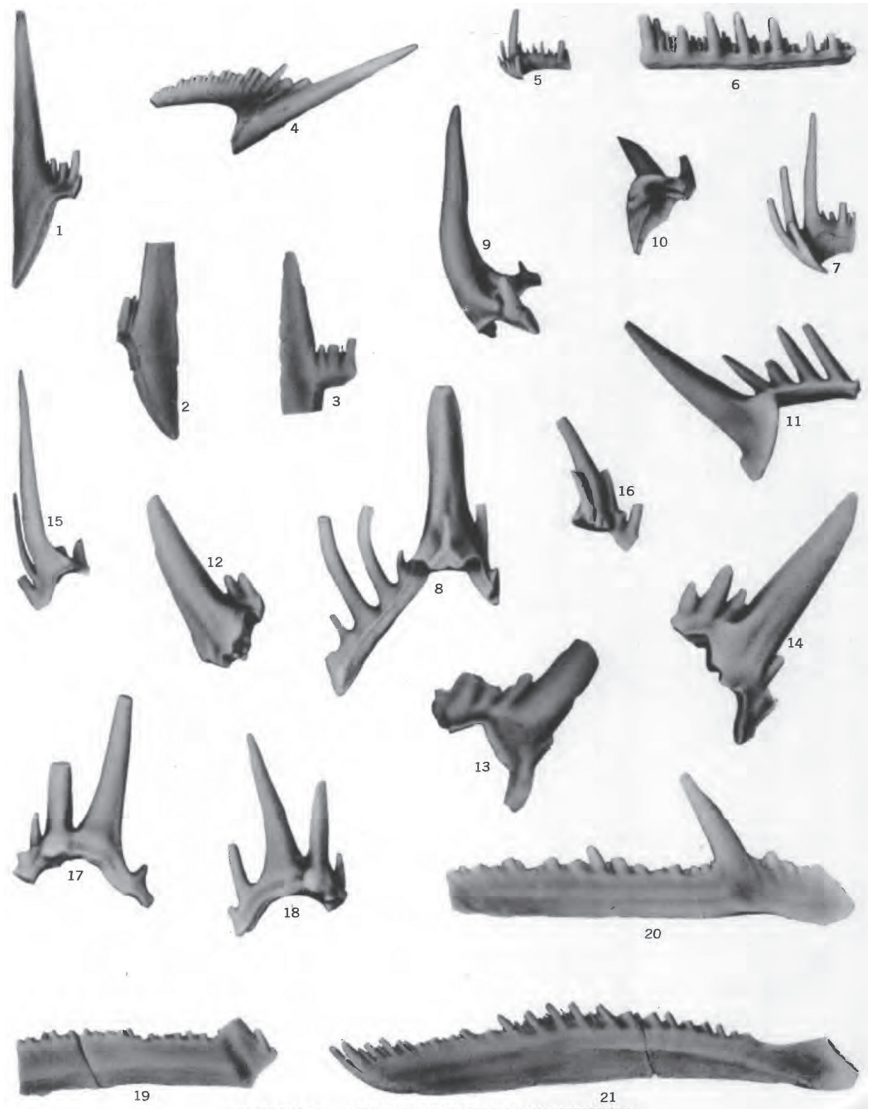
The Topographic Division's $16,323,000 for its topographic surveys and mapping during fiscal year 1952–53 represented an unusual net loss of almost $2,162,000 compared to the funds available in 1951–52. The Division's staff, as of June 30, 1952, numbered 3,159 employees; 2,555 of them served full time,



These specimens represent two new species of the ammonite genus *Metoicoceras* from the Mosby Sandstone (Cretaceous) in central Montana. The wavy-line sutures (figs. 7 and 12) of these cephalopods mark the partitions separating the chambers of their shells. The ammonites occupied the last or body chamber of their shells, as does the living *Nautilus*; figure 14 is a cross-section view of the internal whorls. Comparisons with ammonite faunas in the stage-ages of the global geologic time scale showed that these specimens of *Metoicoceras* lived during the late Cenomanian, an early interval in the Late Cretaceous. (From Cobban, 1953, pl. 6; figs. 1, 3, 5, 8–13, 15, and 16 originally shown at × 1; figs. 2, 4, and 6, at × 2; fig. 7, at × 3; and fig. 14, at × 8.)

16 served part time, and 588 were field assistants and laborers, for a net gain of 593. The $2,703,000 increase in the Division's direct appropriations to $11,090,000, or about 68 percent of total funds, returned more of the program to internal control. That gain, and an additional $113,000 in transfers from the AEC, the MSA, and other Federal agencies, $94,000 more from the USAF, and $22,500 from the USN did not compensate for the Division's expected loss of nearly $4.8 million in Army funds and $352,000 less from the USBR and $36,000 less from States, counties, and municipalities.

Wrather, continuing to decentralize operations, abolished the Special Map Projects Section[182] on October 14, 1952, and transferred to the four regional offices the Section's responsibility for preparing the 1:1,000,000 International series, the 1:500,000 State base maps, the 1:250,000 U.S. series on 468 sheets, and other small-scale maps. To accommodate this work, the Survey order also established a small-scale compilation unit in the Cartography Section of each region. On December 5, Wrather abolished the Trimetrogon Section, which prepared small-scale aeronautical charts and maps for the USAF, and established in the former Section's place a Special Maps Branch to reflect its expanded duties. The additional functions included compiling "large-scale planimetric and topographic maps of standard accuracy" by using "vertical and oblique Kelsh, Multiplex, and other



These specimens of species of *Prioniodus* and species of four other conodont genera were collected from outcrops of the Barnett Formation (Mississippian) in the Mason and San Saba areas in the Llano region of central Texas. These microfossils are phosphatic and shaped like bars, cones, and platforms. They also vary in color, in a sequence determined by USGS geologists Anita G. Epstein (later Harris,) Jack B. Epstein, and Leonard D. Harris to reflect the degree of postdepositional thermal alteration that made them useful in exploration for oil and gas. Conodonts were widespread during the Paleozoic and Triassic. Although the biological function and phylogenetic affinity of the enigmatic conodonts remained undetermined by the 1950s, conodonts were thought to be the bilaterally paired and serially arranged internal parts of early chordates or other small marine animals. Paleontologists subsequently found conodonts in association with soft-body fossils now assigned to early chordates related to modern hagfishes and lampreys. (From Hass, 1953, pl. 16, figs. 1–21; all figures originally shown at × 30; see also Epstein, A.G., Epstein, J.B., and Harris, L.D., 1977; and Knell, 2013.)

stereo-photogrammetric equipment," processing "photographic reproductions up to the press-plate stage for other USGS Divisions and the Aeronautical Chart and Information Service," compiling "maps from radar scope photography" and "radar prediction charts," producing shaded-relief plates, extending horizontal and vertical control by photoalidade to areas of little or no control, and performing "operational research to determine methods and procedures"[183] for mapping areas with unusual conditions.

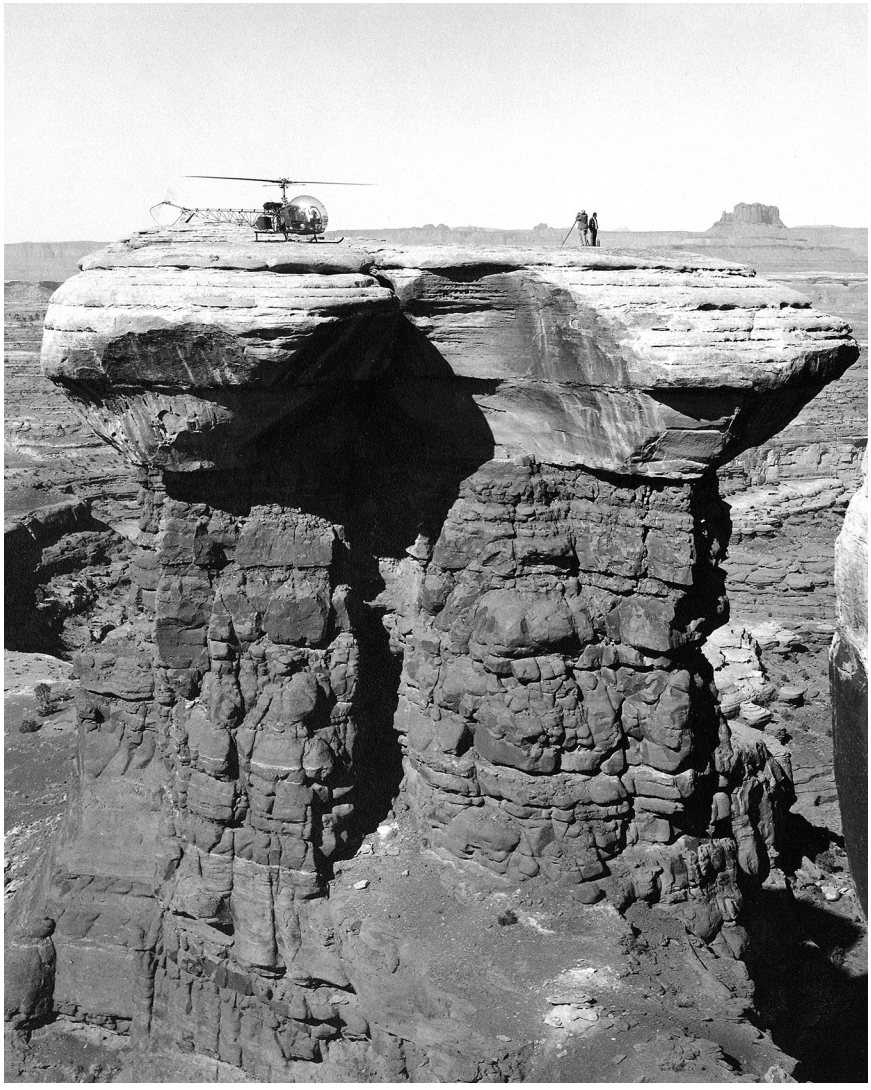
Topographic coverage of the conterminous United States now stood at 67 percent, but only 30 percent represented maps of sufficiently good quality for current use. Wrather estimated that work during fiscal year 1952–53 would add 3 percent but thought that at "this rate, it will take about 25 years to complete mapping of the 48 States."[184] The Division continued to try to speed production and reduce costs while maintaining or improving accuracy. Russell Bean's team redesigned and refitted the Twinplex by replacing the Multiplex projectors with ER–55 projectors. As the new arrangement provided sharper images and greater accuracy for aerial triangulation and map compilation with twin low-oblique photography, CTE FitzGerald expected the improvements to revolutionize mapping techniques. The Division awarded contracts for the ER–55-equipped Twinplex plotters, one for each of the four regional centers, and arranged to deliver four Wild A8 plotters to the same centers. The Division abandoned the Twinplex before it became fully operational when "the successful development of super-wide-angle photography * * * eliminated the advantage of convergent photography."[185] The Division's experiments with equipment provided by the Army Engineers' Research and Development Laboratories showed that low-flying helicopters, constantly observed by the operators of ground-based theodolites, could take supplemental-control photography to considerably reduce required field operations.

Topographic Division managers and engineers thought the great increase in office computing generated by this method could be handled successfully by the AMS's Universal Automatic Computer (UNIVAC) introduced in Philadelphia on June 14, 1951, by engineer-entrepreneurs J. Presper Eckert and John W. Mauchly, who had developed ENIAC in 1946. UNIVAC, a general-purpose and high-speed digital computer, used vacuum tubes in storing and accessing data. The USAF purchased and installed a UNIVAC on February 1, 1952. The USN, for whom the National Cash Register Company constructed a number of the huge automated rapid calculators, or "bombes," to aid the original and later British machines in decrypting the German "Enigma" codes during World War II, used ENIAC and UNIVAC computers to improve gunnery control and in other applications. The Census Bureau, long an innovator in adopting business machines to its use, also acquired and began operating a UNIVAC, continuing a practice the Bureau started when it used for its 1890 and 1900 decennial censuses the electromechanical and punch-card devices designed and built by Herman Hollerith, whose company was one of IBM's predecessors. Topographic Division managers also began thinking about acquiring electronic computers[186] to perform routine calculations.

As the Division's topographic-mapping program in fiscal year 1952–53 remained largely oriented toward meeting the immediate needs of the DoD, mapping in areas outside those of deemed militarily important was limited. Even so, the Division continued double-shift and overtime operations in an effort to meet demands. The Division increased its compilation of maps in the conterminous United States by 18 percent to depict 83,100 square miles and estimated that by the end of 1952–53, about 30 percent of the Nation, excluding Alaska and Hawaii, would be adequately mapped. Division topographers mapped in Hawaii, for publication at 1:24,000, areas of Maui, Molokai, and Oahu and planned, after a priority request from the military, to extend the work to the main island. The Rocky Mountain Region established a permanent office in Fairbanks and named a Resident Engineer, as a complement to the Geologic Division's Resident Geologist,

to coordinate all topographic mapping in Alaska. Mapping in the Territory covered about 12,000 square miles at a scale of 1:63,360, and the Topographic Division published 51 of the provisional series of 1:250,000 maps and compiled the remaining 8 to provide a uniform series for the entire Territory. Topographers in Puerto Rico added 1,500 square miles to the 900 square miles already mapped at 1:30,000 on the island. In cooperation with Interior's Office of Territories, the Division contracted for aerial photography, to be delivered during the winter of 1953–54, as the basis for mapping the U.S. Virgin Islands. In all, the Topographic Division completed more than 1,320 quadrangle maps, a record number, for printing and distribution during 1952–53; of this total, nearly 900 represented new mapping, about 100 were revisions, another 100 were produced by other agencies, and the remaining 220 formed civilian editions of maps previously compiled and published for military use by the DoD. Division members also participated in the 17th International Geographical Congress held in Washington in 1952.

The Topographic Division also expanded its efforts abroad. The Division's mapping program in Brazil supplied bases for USGS geologists to map and study areas having strategic-mineral deposits and prepared specifications and trained Brazilian engineers in topographic mapping by the plane-table method. The USGS, the USCGS, and the Inter-American Geodetic Survey, under their tripartite agreement, each continued to train technicians from other parts of South America and from



In 1953, USGS topographer Chester R. Lloyd and the helicopter pilot established this triangulation station atop the "Toadstools," a tiny mesa more than 1,000 feet above the junction of the Colorado and Green Rivers in the Orange Cliffs area southwest of Moab, Utah. In 1948, the USGS began using helicopters, flown under contract with the aviation industry, to increase the mobility of the agency's topographers and geologists and their access to areas of high elevation and rugged terrain. (From FitzGerald, 1979, fig. 7; also published in Evans, R.T., and Frye, 2009, fig. 22. See also the pre-landing photograph in Rabbitt, M.C., 1954, p. 355.)

Central America. Division members negotiated the contract for aerial photography, map compilation, and mosaics in Saudi Arabia as a project of the Point Four Program[187] for Glen Brown's team; completed the cooperative work, for the ECA, with the British Colonial Surveys in Kenya, Tanganyika (Tanzania), and Uganda; and provided the Mutual Security Agency with specifications for and advice about mapping areas in Angola and Mozambique; they also supplied advice about a large-scale, commercial topographic-mapping project in the Philippines later supervised by the Army Engineers. With MSA support, Division photogrammetric and topographic specialists provided advice and worked on map compilation in Burma and Jordan. Some of their colleagues also advised U.N. agencies.

The Water Resources Division's total funds for investigations during fiscal year 1952–53 increased by about $733,000 to nearly $13,175,000, of which nearly $6,115,000, or about 46 percent, came from direct appropriations for salaries and operations. The Division's staff, as of June 30, 1952, consisted of 2,103 persons, of whom 1,632 worked full time, 88 worked part time, and 383 others served as field assistants and laborers, for a net loss of 8 employees, reflecting separations, transfers, and activations or drafts for military service. Transfers of $41,000 from the USAF and $237,000 from the Army, offsetting the Navy's reduction of nearly $28,000, increased the Defense Department's contributions to a total of about $1,229,000. This gain plus $115,000 from the MSA and other Federal agencies exceeded losses of some $144,000 from the USBR and two other Interior agencies, $97,000 from the AEC, and $47,500 from the DoS. Cooperative monies received from States, counties, and municipalities continued their slow rise, this time by some $319,000 to nearly $3,604,000, or more than the $3.5 million of the Division's direct appropriation available only for that work.

During the year, members of the Division continued to study public water-supply needs and those of industry. They published nine preliminary reports on the water supplies of more than 1,200 of America's larger cities to update the information contained in the 1932 report about their industrial utility. Ongoing or new studies of industry's requirements included those for the producers of acetate, aluminum, nylon fiber, and rayon. Division personnel completed a report on the pulp and paper industry for use by defense agencies and began work on a similar summary for public release. For the NSRB, they started a series of integrated reports summarizing and evaluating water resources of specific areas to provide defense agencies with adequate appraisals. During the year, Division members completed 5 of the 13 studies underway of large industrial centers. At the request of the House Committee on Interior and Insular Affairs, they aided the preparation of a series of documents, "The Physical and Economic Foundation of Natural Resources," compiled to provide facts to guide the realization of a sound natural-resources policy for the Nation's economy. In cooperation with other Federal agencies, the Division undertook a program of coordinating and disseminating drainage-area data to try to achieve consistency in their use. Division members, supported principally by the MSA, continued surface-water- and groundwater-resources investigations in Afghanistan, India, Iran, Libya, and Saudi Arabia, while some of their colleagues field-trained visiting hydrologists from India, Israel, Pakistan, the Philippines, Thailand, and Turkey.

On July 3, 1952, President Truman signed the Saline Water Act "to provide for research into and development of practical uses for the economical production from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses."[188] To support this work, the statute provided $400,000 for each of the next 5 years, gained through efforts by Chairmen Clair Engle, of the House Subcommittee on Reclamation, Joseph O'Mahoney, of the Senate Committee on Interior and Insular Affairs, and many of their congressional colleagues in the 81st and 82d Congresses. In view of "the

acute shortage of water in the arid areas of the Nation and elsewhere," and "the excessive use of underground waters throughout" America, Congress hoped to develop "a practicable low-cost means" of production "on a scale sufficient to determine the feasibility of the development of such production and distribution on a large-scale basis."[189] The new law gave the Interior Secretary authority to act, through the Department's agencies, to conduct research and technical development, make engineering studies, determine best designs and operations for plants, acquire information and lands, and cooperate with other organizations in adding economically to the Nation's supply of freshwater. The statute provided up to $2 million for 5 years, provided that the cost of correlating and coordinating information did not exceed $500,000. The USGS Water Resources Division participated in Interior's saline-water program by having a member of its staff serve on the Advisory Committee on Saline-Water Conservation.

During 1952–53, the Surface Water Branch continued to collect records of stream discharge at about 6,400 gaging stations nationwide, including nearly 300 in the Missouri River Basin and 488 in Alaska and Hawaii Territories. Members of the Branch advanced the compilation and condensation into one volume of all streamflow records prior to 1950 for each area covered by an annual report on surface-water supply. They gave increasing attention to the nationwide collection of data on water temperatures, making regular readings at more than 300 sites (plus 50 self-recording stations), to satisfy the growing demand for information by the users of streams for cooling and other industrial purposes. The Branch completed the preliminary design of and issued invitations for contracts for constructing a development model of an electronic computer to compile daily streamflow records. Branch personnel, on completing an investigation of the water flow through single constricted openings, expected the results to aid the design of future bridges. The Branch also operated 114 sediment stations on streams in the Western United States and continued its studies of the origin of sediments and how they enter stream channels, are transported, and finally deposited, including ongoing work on the amount of sediment carried as bedload at six locations in the Missouri and Rio Grande Basins. Branch members also completed more than 60,000 measurements of sediment content at 89 stations in the Missouri Basin. To improve sediment sampling, the Branch, in collaboration with other Federal agencies, developed a visual-accumulation tube for rapid and accurate determinations of the distribution of particle size in sands. During the year, the Branch published six reports on floods, three others on flood frequency, and four evaluations of river basins in the Pacific Northwest to show the influence of manmade structures on discharge records.

Investigations by the Ground Water Branch during 1952–53 included studies of groundwater occurrences and movement and saltwater encroachment. Branch personnel completed for the Army Engineers a three-part report on "Ground-Water Development in the Arctic," covering the geological, geophysical, and aerial-photographic interpretation of permafrost terrain. Work in a part of South Dakota's James River Basin delineated an aquifer that could yield water sufficient to support irrigation in that area. Branch members began studying the effect of groundwater movement on the accumulation of oil and gas in Wyoming's Bighorn Basin. Saltwater encroachment claimed more attention during the year. The Branch released a report that described conditions in southwestern Louisiana where the movement of saltwater from the Gulf of Mexico and tidal streams into the freshwater aquifers had created serious problems. Continuing investigations in other areas of saltwater encroachment included those in the Trinity River of Texas, in South Carolina's Combahee River, and in the lower Delaware River. Branch personnel further studied the possibility of establishing a freshwater barrier to prevent saline encroachment in California's Manhattan Beach area. Encroachment problems in Florida led to additional work to determine the origin and extent of saltwater

migration into freshwater aquifers, and the Branch began to investigate the effects of reducing the migration of saline water into aquifers by recharging them with freshwater. Robert R. Bennett and Rex R. Meyer finished their report on the hydrogeology of the Baltimore area, which included an early use of flow-net analysis. The Branch also began issuing, as a training technique, its series of "Ground Water Notes." From March 1952 to March 1953, hydrologist Donald F. Dougherty joined the USGS team in Saudi Arabia, where he assessed runoff characteristics of ephemeral streams and surface-storage and groundwater-recharge potential near Riyadh. At the MSA's request, the Branch sent Leonard J. Snell to Afghanistan to begin, in June 1952, long-term aid in collecting and evaluating the streamflow data required to manage and operate the new and American-built engineering works in the Daryē Helmand Basin.

The Quality of Water Branch broadened its studies of chemical quality during fiscal year 1952–53 to evaluations of mineral pollutants in natural waters by including analyses for trace metals and other minute dissolved constituents whose occurrences influenced the use of water supplies for specific purposes. To support this work administratively, the Branch established a Physical Quality Section, led by Raymond B. Vice. Branch members also looked more carefully at the duration and frequency of low flow in streams, because the allocation of water often depended on the volume of water available for dilution. For the USAF and the Army, they continued studies of the potability of water at continental and offshore installations. For the Missouri River Basin project, they analyzed chemically more than 10,000 water samples from 28 stations. The Branch also began a program, supported by the AEC and served by the nearly completed laboratory facilities at Denver, to determine and interpret "background" or natural radioactivity and trace elements in water samples.

The Conservation Division received from all sources nearly $1,440,000 for its operations in classifying lands and supervising mining and oil and gas leases during fiscal year 1952–53. The $108,000 increase included nearly $95,500 more in direct appropriations for the latter function. As of June 30, 1952, the Division staff still numbered 233 persons, but it now comprised 215 full-time employees, 3 part-timers, and 15 field assistants and laborers. Direct appropriations, transfers by the Navy and Federal civilian agencies, and nonfederal cooperative funds for land classification in 1952–53 rose by just under $2,700, but the same sources supplied nearly $105,000 more for supervising mining and oil and gas leases.

The Division's four Branches extended their operations during the year. Members of the Mineral Classification Branch acted on some 19,260 cases, a decrease of 8,800 (about 31 percent) from the number handled in 1951–52. They also completed for internal and external use specific reports, requested by geologists in field offices, on coal, oil and gas, oil shales, and fluorspar deposits in areas in California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming. The Mining Branch supervised about 1,260 properties, an increase of 60 from the previous year. Domestic production of coal again decreased nationwide, although it increased in Alaska. The five operating mines on public lands in New Mexico's potash field produced a total of more than 7.6 million tons of crude potassium salts, up from 5.4 million tons in fiscal 1951–52, and new mines were expected to be opened to develop reserves disclosed by geologic studies and core drilling. The Oil and Gas Leasing Branch supervised nearly 78,790 oil and gas properties on the public lands, about 2,010 leases on acquired lands, and some 8,270 leaseholds on Indian lands. The year's royalties from increased oil and gas produced from the public and acquired lands in 1952–53 reached nearly $32 million, revenue from the Indian lands amounted to about $16.5 million, and the NPR–2's yield reached $905,000, an increase of nearly $88,500 from 1951–52. Approval of new and termination of existing unit plans left 267 such plans in effect at the end of fiscal

1952–53. The Branch also contracted for the exploration and development of nearly 1 million acres of land in the Katalla-Yakataga area of southeastern Alaska. The Water and Power Branch continued to survey dam and reservoir sites and river channels; its members also supervised the construction and operations of 1,005 projects—134 licensed by the FPC, 671 Interior Department efforts, and 200 others in cooperation with the BIA—an overall increase of 65 from 1951–52.

On July 7, 1952, less than a week after the beginning of the new fiscal year, the Republicans met in Chicago to select their national ticket for the election in November. Taft and Eisenhower competed for the Presidential nomination. Both parties sought Eisenhower before and after he ended his tour as SACEUR in June. Truman offered to run as a candidate for Vice President in 1948, if Eisenhower would accept the top slot, but Truman failed to convince Eisenhower, who expected Dewey would win, to campaign as a Democrat. Eisenhower, who increasingly deplored many of Truman's policies, decided in 1951 to seek what he termed a greater duty. Herbert Brownell, Jr., who managed both of Dewey's campaigns and briefly led the Republican National Committee, went to Paris early in 1952 and told Eisenhower that Taft's projected lead required Eisenhower to fight for the nomination. Eisenhower authorized Brownell, Clay, Dewey, Lodge, and others to form an exploratory committee and enter him in the Republican primaries in New Hampshire, where he defeated Taft, and in other States. Brownell's "Fair Play" resolution resolved the dispute about seating delegates from several Southern States. MacArthur also was a candidate, disproving his assurance to Truman on Wake Island that Eisenhower would be the only five-star general to seek the Presidency. MacArthur gave the keynote address, but on the first ballot, the delegates chose Eisenhower. To balance the ticket and win back conservatives, the delegates selected California's Senator Richard M. Nixon for the second slot. Nixon moved from the House to the Senate in 1947 after campaigns in which he successfully played the soft-on-Communism card against both incumbents. After the convention, MacArthur ran in seven States as a candidate of the Christian Nationalist and Constitution Parties.

Eisenhower resigned his Army commission; having published "Crusade in Europe" in 1948, he now pledged to lead another crusade against the Democrats. The Republican platform promised to end the protection of subversives in the Federal Government; preserve the Taft-Hartley Act; reduce Federal power by returning some of it to local and State governments, including managing the coastal tidelands and their energy and other natural resources; secure statehood for Alaska and Hawaii; rebalance the national budget and restore equilibrium between Federal activity and private enterprise; and weigh more equally national resources and international commitments. The Republicans, again decrying Roosevelt's agreements at Yalta and Truman's containment of the Soviet Union, also pledged, in a plank written by John Foster Dulles, to liberate Eastern Europe. On August 14, Truman invited Eisenhower to the White House. Eisenhower refused, saying that he would only attend in the event of a major emergency, but he did accept, with Truman's approval, situation reports from the CIA.

On July 21, Democrats also met in Chicago to choose their new national slate. C. Estes Kefauver of Tennessee, the liberal Senator who defeated Truman in the New Hampshire primary and subsequent primaries, led on the first two Presidential polls. Truman, although not limited by the Constitution's Article XXII of 1951 that restricted future Presidents to two elected terms, or one if they had already filled more than 2 years of a unelected term, declared on March 29 that he would not seek reelection or accept renomination. Truman then threw his support to Adlai E. Stevenson 2d, the conservative grandson of Grover Cleveland's Vice President and Illinois' Governor since 1948. Delegates nominated Stevenson on the fourth ballot. Stevenson chose as his running mate not Kefauver but the more moderate Senator John J. Sparkman of Alabama, a Dixiecrat in 1948. Stevenson and Sparkman

campaigned to continue Truman's domestic and foreign policies, including supporting NATO, repealing Taft-Hartley, and enacting Federal legislation to improve civil rights for all American citizens. Truman, before campaigning for the Democratic ticket, previewed the Federal budget for fiscal year 1953–54, through which the deficit would be reduced to $10.3 billion and which included $3.6 billion for natural-resources work, a reduction of $706 million.

As the national political campaigns played out during the summer and fall of 1952, both the war and the armistice talks in Korea remained deadlocked. United Nations and Communist forces, the latter increasingly stronger in artillery, alternated limited offensives on rugged land that required a grueling combat between the opposing infantry forces. U.S. casualties rose to more than 110,000, with another 13,000 listed as missing. In the air, bombs from Air Force, Marine, and Navy aircraft destroyed North Korea's last major industrial target, its electrical grid. Jet-to-jet aerial combat now involved wing-size engagements over northern North Korea. When Soviet swept-wing Mikoyan-Gurevich (MiG)-15s, flown by Russians and Chinese from airfields across the Yalu, struck U.S. bombers, fighter-bombers, and their escorts of swept-wing, North American F–86 Sabres, kill ratios rose steadily in favor of the U.S. pilots. At Panmunjom, after the Communists rejected the U.N.'s final offer on prisoner exchange, Lt. General William K. Harrison, Jr., who had replaced Vice Admiral Joy, led the U.N. representatives in walking out.

As the war continued, American industry began developing, continued testing, or introduced new technology—aircraft carriers, bombers, cannon, missiles, and submarines—between April and December 1952. Boeing started flying its new B–52 eight-jet Stratofortress bomber. Army Secretary Frank Pace, Jr., announced the development of a 280-mm artillery piece that would fire atomic shells. Truman, Navy Secretary Dan A. Kimball, and AEC Commissioner Gordon E. Dean attended the keel-laying of the nuclear-powered submarine *Nautilus*. When completed, under the direction of Captain Hyman G. Rickover (the Navy's General Groves), *Nautilus* would realize Philip Abelson's 1946 proposal to the Naval Research Laboratory (NRL), in response to a recommendation to give priority to ship propulsion as the major initial postwar use of atomic energy.[190] The keel was laid for the supercarrier *Forrestal*, a ship intended to replace the stillborn *United States* and use British-style angled flight decks, mirror-landing system, and steam catapults. The Navy completed its test submarine *Albacore*, with a teardrop-shaped hull that produced submerged speeds of more than 30 knots. Tests continued of the Navy's Regulus cruise missile, an improved Loon developed from the German V–1 and intended to be launched from surface ships or from surfaced submarines. Grumman started flying its propeller-driven JF–2 Tracker, an early warning aircraft, and the USAF began testing its new Sidewinder air-to-air missile.

In the year before the U.S. national election in 1952, other significant events in the Middle East, Africa, and the Far East combined to increase the Truman administration's burdens and uncertainties in foreign affairs. Recent developments in Iran, which provided 40 percent of the Middle East's petroleum as Daniel Yergin later recorded, seemed to threaten the world's oil supply. Anglo-Iranian, then the third-largest producer globally, controlled production, prices, and profits; the Shah's government received 36 percent of Iran's oil revenues. The Iranians wanted a 50:50 split[191] like the existing arrangement in Venezuela and the new agreement between Aramco and Saudi Arabia announced on December 30, 1950. George C. McGhee, a wealthy geophysicist, DeGolyer's son-in-law, and the U.S. Assistant Secretary of State for Near Eastern and African Affairs, brokered the deal with the Saudis and now tried to reach a similar understanding in Iran. After the Shah's premier refused Anglo-Iranian's offer of greater royalties and other payments, the Saudi announcement forced Anglo-Iranian to propose a 50:50 sharing. Mohammed Mossadegh

(Mussaddiq), a former professor of political science and now head of the Iranian parliament's oil committee, wanted nationalization. When the premier opposed that option, he was assassinated. On April 28, 1951, the parliament chose Mossadegh, who also led the National Front, as the new premier. The Shah signed an authorization to nationalize Anglo-Iranian effective May 1.

Bruce Brown's Petroleum Administration for Defense predicted that the resulting loss of oil would raise global demand above supply before year's end. The PAD helped the Truman administration to form a volunteer group of 19 petroleum companies to cooperate in blending facilities, operations, and supplies; these efforts, depending heavily on increased production by the United States, Iraq, Kuwait, and Saudi Arabia, raised world output by 2 million barrels per day in 1952 despite a 97-percent loss in supplies from Iran. On May 26, as Yergin described, Britain referred the dispute to the International Court of Justice at The Hague. Truman and Acheson sent Harriman to Tehran in mid-July to aid a British delegation negotiating with Mossadegh. When the mission failed, Britain increased its economic warfare against Iran and considered military action. Mossadegh rejected the British response to his ultimatum of September 12, and Iranian armed forces occupied the oil terminal, refinery, and port facilities at Abadan. The British petitioned the U.N. Security Council without favorable result and evacuated Abadan on October 4, although Churchill warned that securing Middle East oil was more important than holding South Korea. Iran submitted its case to the International Court on December 10, but that body, on July 22, 1952, decided it lacked jurisdiction. After the British refused Mossadegh's proposed settlement, Iran ended diplomatic relations with Britain on October 22. The British and U.S. Governments then planned a countercoup against Mossadegh to defend Anglo-Iranian and counter growing Soviet influence.

By then, the Governments of Egypt and Libya had changed as well, as had the situations in Iraq, Kenya, Malaya, and Indochina. In October 1951, Mustafa al-Nahhas, Egypt's Prime Minister, abrogated the Anglo-Egyptian Treaty of 1936, and Egyptian guerrillas increased their attacks on the Suez Canal during November 1951–January 1952. The U.N. General Assembly's resolution of November 21, 1949, approved an independent Libya by January 1, 1952, but Libya became independent on December 21, 1951, under its new constitution prepared by the National Assembly, which formally recognized Mohammed Idris el-Senussi as King Idris I. Libya joined the Arab League in February 1952. On July 23, 1952, an Egyptian officers' coup, led by Army General Mohammed Naguib and Colonel Gamal Abdel Nasser, overthrew King Farouk, who abdicated and left the country. Nasser, who supported the Germans in World War II, and was imprisoned with the younger Anwar Sadat, repeated some of the land and other reforms begun by Colonel Ahmed Arabi and other nationalist officers who rebelled in 1881–82. Egyptian reforms now produced longer lasting results. Also in 1952, the Baa'th Party was founded in Iraq, the Mau Mau rebellion and its terrorism began in British Kenya, and the British counterinsurgency war continued in Malaya. In Indochina, the French forces' success in defending the air-land advanced base at Na San in the northwest highlands during November–December 1952 suggested that using these tactics in other areas far beyond the fortified line around the Red River delta could win the war.

At home, issues involving inflation, labor, and materials also influenced America's political campaigns in 1952. Truman, to avert a planned strike for higher salaries by 600,000 American steelworkers, ordered on April 8 a Federal seizure of the mills. On June 2, the U.S. Supreme Court upheld an earlier decision rejecting the President's action because it lacked authority under the Constitution or from Congress. When Truman returned the steel mills to their owners, the workers promptly walked out. The President invited representatives of the owners and

the unions to the White House, where they reached a compromise on July 24 that ended the 54-day strike but led to increased prices as well as wages. On June 27, Congress extended rent and wage controls and priorities for allocating materials, and passed, over Truman's veto, the Immigration and Nationality (McCarran-Walter) Act,[192] which codified and revised U.S. immigration and naturalization laws and established a Joint Committee on Immigration and Nationality Policy. The new statute maintained the 1924 Immigration Act's provisions for a quota system based on numerical limitations derived from a count of national origin, one-sixth of 1 percent of the people in the continental United States in 1920. The law continued the existing annual quota of 100 for Chinese immigrants, but it eliminated prohibitions on accepting people with at least one-half local ancestry from areas within the so-called Asia-Pacific triangle. The act established methods to screen persons considered undesirable or subversive, including restrictions on qualifications for admission, the registration and control of travel by aliens and citizens who were Communists in times of war or national emergencies, and the management of visas, reentry permits, and exclusions. The law authorized measures for controlling U.S. citizens abroad and also defined nationality at birth and measures for collective naturalization (including service in the U.S. armed forces) and the retention or loss of nationality status. As an aid to the American agricultural and other industries, the law also increased access for the "bracero" program for Mexican day workers and immigration from Puerto Rico.

Stevenson enjoyed an early lead in the polls, but Eisenhower and Nixon campaigned effectively against Truman's policies toward China and in Korea, and the alleged and demonstrated corruption in his administration at home, including improper gifts, kickbacks, and other alleged malfeasance by some of its members. "I like Ike," an increasingly effective Republican slogan, trumped "We need Adlai badly," while Truman, his approval rating with the voters still below 30 percent, remained the least popular President in recent times. The campaign's tone, however, rapidly worsened. Truman campaigned widely and sometimes savagely against Eisenhower, who said he hated partisan politics and took personally the President's attacks. Republicans labeled Stevenson an "egghead," an intellectual too removed from reality to remember to repair the sole of his worn shoe. On September 23, Nixon's televised "Checkers" speech, named for the dog received as a gift, highlighted the virtues of his wife's cloth coat and other examples of his alleged lack of wealth. Nixon's performance, maudlin but effective theater, successfully defused charges that he had maintained an illegal slush fund to advance his political agenda. The next day, Eisenhower announced that Nixon would remain on the ticket. In Denver, Eisenhower refuted McCarthy's bogus charge that Ike's mentor Marshall was "soft" on Communism. Before appearing with McCarthy in Milwaukee on October 3, Eisenhower blasted McCarthy in private but, influenced by Senator Knowland and Wisconsin's Governor Walter J. Kohler, Jr., deleted his defense of Marshall from his more widely reported public speech. When the Communists still refused to consider the voluntary repatriation of Chinese and North Korean prisoners held by the U.N., on October 8, negotiators recessed indefinitely the talks at Panmunjom. Eisenhower pledged in Detroit on October 24, during the last speech of his own whistle-stop campaign, to concentrate on ending the Korean war and to go there if elected. When Truman immediately offered Eisenhower passage on a Federal aircraft to Korea, the Republican candidate declined.

On November 4, Eisenhower swamped Stevenson in the national election, receiving 55 percent of the popular votes and 442 of the 531 electoral votes. The five candidates of the six minority parties received a total of less than 261,000 popular votes, and MacArthur emerged next-to-last among them. The Republicans also won the House and the Senate. In the 83d Congress, they would have a 1-seat majority in the Senate, not including Oregon's Wayne L. Morse as an Independent, and a 10-seat edge in the House, also with 1 Independent.[193] On November

5, Truman asked all Americans to "close ranks and work together for our mutual welfare as citizens of this great Republic."[194] On November 29, Eisenhower left in secret by air for Korea. During December 2–5, he met with Generals Clark and Van Fleet but spent most of those days visiting front-line areas. As Eisenhower did before the Normandy invasion, he tried to gain firsthand a better appreciation of the morale of the troops and now also something of the terrain on which they fought. Eisenhower returned from Korea in a Navy cruiser, using the long voyage to plan his administration in conversations with Herbert Brownell, Jr., Foster Dulles, George M. Humphrey, and other advisers.

While Eisenhower returned from Korea by sea, Truman, Churchill, and French Premier Joseph Laniel met in Bermuda during December 4–7 to review Big Three policies toward and relations with the Soviet Union, West Germany, and Austria and the current efforts in defense of the free world. Truman and Churchill met again in Washington during January 5–9, 1953, to discuss common policies for dealing with their domestic and international problems, including exchanging additional raw materials, increasing support for NATO, and ending the war in Korea. Churchill, who opposed extending the war to mainland China, held similar but briefer talks with Eisenhower in New York on January 5.

The Truman administration during its last weeks in office received and issued several documents, with recommendations for improving Federal management, science, and engineering. On December 31, 1952, Budget Bureau Circular A–47 contained reports about and budget estimates for Federal programs and projects for the conservation, development, or use of water and related land resources, including water supply.[195] The Missouri River Basin Survey Commission,[196] founded by Executive order on January 3, 1952, presented its final report, "Missouri: Land and Water," on January 12, 1953. Chairman James E. Lawrence, editor of the *Lincoln Star;* vice chairman and Senator Thomas C. Hennings, Jr. (D–MO); Senators James E. Murray (D–MT) and Milton Young; Representatives Clifford R. Hope (R–KS) and James W. Trimble (D–AR); and several engineers and farmers, some of whom also managed farm organizations or served in State legislatures, recommended specific actions to better protect, develop, and use the Nation's water resources. The next day, NSRB Chairman Gorrie sent his summary report to the President for publication later in 1953. On January 16, BoB Circular A–16 specified procedures for "Programming and Coordination of [Federal] Topographic Mapping."[197] Circular A–16 made the Interior Department responsible for the National Topographic Map Series and outlying areas of U.S. sovereignty and jurisdiction for the National Atlas. The Commerce Department received responsibility for the National Networks of Geodetic Control. The Circular asked agencies requiring maps in the National Topographic Series to prepare annually a priority statement of such needs in three levels—within 3 years, within 4 years, and after 4 years. Circular A–16 also required the map-making agencies to prepare program maps showing the areas where mapping 1:24,000 and 1:62,500 quadrangles would begin during the next fiscal year and specifically asked the USGS to prepare and publish semiannually maps showing the progress of mapping. The Circular made the USGS responsible for the collection, publication, and distribution of Federal topographical data and information. Truman also transmitted to Congress the varied evaluations by executive branch agencies of the report by the President's Water Resources Policy Commission, including the congressionally authorized basic surveys of three regions—New England-New York; the Arkansas-White-Red River Basins; and the Missouri River Basin—for their sensible development. The Commission recommended decentralized but unified or coordinated administration for these resource programs. Not all the agencies agreed.

On January 9, 1953, Truman's budget message presented his revised view of what expenditures and receipts might have been expected in fiscal year 1953–54

under a Democratic administration—$78.6 billion in expenditures, $68.7 billion in receipts, and a deficit further reduced to $9.9 billion. The $4.1 billion now proposed for activities in natural resources included $1.1 billion for developing land and water resources, with $500 million specifically for the river-basin development projects directed by the AEC and the USBR, but full or partial implementation depended on decisions by the new President.

Truman's second administration did not achieve the foreign-policy goals that he set forth in his inaugural address in 1949 or most of his domestic initiatives proposed in the Fair Deal. His stormy relations with organized labor in 1951–52 over mobilization, wage, and related policies contributed to Democratic defeat at the polls. Truman could say accurately that the United States successfully met the challenge of two of the Nation's largest postwar concerns—the growing struggle against Communist expansion abroad and the continuing conservation of resources at home. On Truman's watch, the strong movement to conserve natural resources, begun in the 1930s, usually prevailed over the proponents of monopoly, exploitation, and waste. Truman, in his State of the Union Message on January 7, 1953, predicted "a long hard test of strength and stamina, between the free world and the communist domain."[198] Eight days later, in his farewell address to the Nation, the President also forecast that "when history says that my term of office saw the beginning of the cold war, it will also say that in those 8 years we have set the course that can win it."[199] Truman believed that as the free world grew "stronger, more united, and more attractive to men on both sides of the Iron Curtain," and "the Soviet hopes for easy expansion are blocked," in time a major transformation would occur in the Soviet sphere, although no one could know exactly when or how it would happen. The change, Truman suggested, could come

> **by revolution, or trouble in the satellite states, or by a change inside the Kremlin. Whether the Communist rulers shift their policies of their own free will—or whether the change comes about in some other way—I have not a doubt in the world that a change will occur.[200]**